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Memorandum

To: Regional Director, Region 2, Albuquerque, New Mexico

Through: Assistant Regional Director, Ecological Services, Region 2, Albuquerque, New Mexico

From: Field Supervisor, Austin Ecological Services Field Office, Austin, Texas

Subject: Biological and Conference Opinions for the Edwards Aquifer Recovery Implementation Program Habitat Conservation Plan – Permit TE-63663A-0 (Consultation No. 21450-2010-F-0110)

Enclosed are the biological and conference opinions for the final Edwards Aquifer Recovery Implementation Program (EARIP) Habitat Conservation Plan (HCP) that describes actions the Applicants have proposed to avoid, minimize, and mitigate adverse effects to the endangered Texas wild-rice (*Zizania texana*), Comal Springs dryopid beetle (*Stygoparnus comalensis*), Comal Springs riffle beetle (*Heterelmis comalensis*), Peck's Cave amphipod (*Stygobromus pecki*), fountain darter (*Etheostoma fonticola*), San Marcos gambusia (*Gambusia georgei*), Texas blind salamander (*Typhlomolge [=Eurycea] rathbuni*), the threatened San Marcos salamander (*Eurycea nana*), and the non-listed Texas cave diving beetle (*Haideoporus texanus*, also referred to as the Edwards Aquifer diving beetle), Texas troglobitic water slater (*Lirceolus smithii*), and Comal Springs salamander (*Eurycea* sp.) over a period of 15-years. We appreciate your staff's assistance throughout this consultation. If you have any questions regarding this biological opinion, please contact Tanya Sommer at 512-490-0057, extension 222.

The biological opinion is based on the EARIP HCP dated December 2011 and the associated Environmental Impact Statement dated June 2012 pursuant to the National Environmental Policy Act of 1969; U.S. Fish and Wildlife Service (Service) files; discussions with species experts; published and un-published literature on the species of concern and related impacts; and other sources of information available to the Service. A complete administrative record of this consultation is on file at the Austin Ecological Services Field Office.

Attachment

cc: Mike Oetker, ARD-FARC, USFWS, Albuquerque, New Mexico
Tom Brandt, San Marcos Aquatic Resources Center Director, USFWS, San Marcos, Texas
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BIOLOGICAL AND CONFERENCE OPINIONS

This document transmits our biological and conference opinions for the issuance of a U.S. Fish and Wildlife Service (Service) 10(a)(1)(B) permit (Permit) for the Edwards Aquifer Recovery Implementation Program (EARIP) Habitat Conservation Plan (HCP) to the Edwards Aquifer Authority (EAA), the City of New Braunfels (CNB), the City of San Marcos (CSM), San Antonio Water System (SAWS), and Texas State University (TSU) (the Applicants).

The EARIP HCP will minimize and mitigate, to the maximum extent practicable, adverse effects from covered activities to the endangered Texas wild-rice (*Zizania texana*), Comal Springs dryopid beetle (*Stygoparnus comalensis*), Comal Springs riffle beetle (*Heterelmis comalensis*), Peck's Cave amphipod (*Stygobromus pecki*), fountain darter (*Etheostoma fonticola*), San Marcos gambusia (*Gambusia georgei*), Texas blind salamander (*Typhlomolge [=Eurycea] rathbuni*), the threatened San Marcos salamander (*Eurycea nana*), and the non-listed Texas cave diving beetle (*Haideoporus texanus*, also referred to as the Edwards Aquifer diving beetle), Texas troglobitic water slater (*Lirceolus smithii*), and Comal Springs salamander (*Eurycea* sp.), pursuant to the Endangered Species Act of 1973, as amended (Act) (16 U.S.C. 1531 et seq.). The issuance of a Service permit to authorize incidental take associated with the HCP is pursuant to 10(a)(1)(B) of the Act and is the action for this intra-Service consultation pursuant to section 7 of the Act.

1. Consultation History

January 6, 2012	The EARIP submitted a draft HCP and an application for an Incidental Take Permit (ITP) to the Service; and,
July 20, 2012	The Service posted a Notice of Availability of a dEIS and a draft HCP, an announcement of public hearings during a 90-day public comment period, and a request for comments in the *Federal Register* (77 FR 42756); and,
July 2012	Notices that the Service would host seven public review hearings were published in area newspapers, including The Corpus Christi Caller Times, The Kerrville Daily Times, The New Braunfels Herald-Zeitung, The San Antonio Express-News, The San Marcos Daily Record, The Uvalde Leader, and the Victoria Advocate; and,
August 3-15, 2012	Seven public review hearings were held in Corpus Christi, Kerrville, New Braunfels, San Antonio, San Marcos, Uvalde, and Victoria, Texas; and,
October 9, 2012	Letter received stating that after reviewing the dEIS, the Environmental Protection Agency (EPA) concluded their review with a rating of "LO" or "Lack of Objections", thereby indicating that the dEIS adequately set forth the environmental impacts of the preferred alternative and those of the alternatives reasonably available to the project or action, that no further analysis or data collection was necessary, and that the EPA did not identify any potential environmental impacts requiring substantive changes to the preferred alternative; and,

October 18, 2012 Public comment period for the DEIS closed; and,

November19, 2012 Final draft HCP and EIS submitted.

2. Description of the action

Section 7 of the Act requires that all Federal agencies consult with the Service to ensure that Federal actions authorized, funded, or carried out by such agencies do not jeopardize the continued existence of any threatened or endangered species or result in the destruction or adverse modification of designated critical habitat. This biological opinion does not rely on the regulatory definition of "destruction or adverse modification of critical habitat" at 50 CFR 402.02. Instead, we have relied on the statutory provisions of the Endangered Species Act to complete the analysis with respect to critical habitat.

The Federal action requiring consultation is issuance of a section 10(a)(1)(B) permit for the incidental take of listed species resulting from the Applicants' otherwise lawful non-Federal activities including the regulation and production of groundwater in accordance with State law for irrigation, industrial, municipal, domestic, and livestock purposes; the use of the Comal River and San Marcos River for recreational uses; operational and maintenance activities that could affect Comal Springs, San Marcos Springs, and the associated river systems; and activities necessary to manage potential habitat for the covered species within the permit area.

The EARIP HCP submitted by the Applicants as part of the incidental take permit application and the EIS analyzing the potential environmental consequences of approving the application are hereby incorporated by reference.

Section 7(a)(2) of the Act's implementing regulations defines the action area as all areas affected directly or indirectly by the Federal action and not merely the immediate area affected by the project (50 CFR § 402.02). For the purposes of this biological and conference opinion, the action area includes the permit area and any area where HCP implementation is expected to affect listed species or designated critical habitat within the contributing, recharge, and artesian zones of the Southern segment of the Edwards Aquifer, or areas impacted by discharges from the Edwards Aquifer into the Guadalupe River Basin downstream of Comal and San Marcos Springs. The action area therefore includes the eight counties within the general jurisdiction of the EAA (Atascosa, Bexar, Caldwell, Comal, Guadalupe, Hays, Medina, and Uvalde), the four counties within the EAA five mile water quality buffer (Edwards, Kendall, Kinney, and Real), and five counties affected by the discharge of springflow carried downstream by the Guadalupe River to the Guadalupe River Estuary and San Antonio Bay (Calhoun, Dewitt, Gonzales, Refugio, and Victoria). This 17-county action area coincides with the study area described in the EIS, and is illustrated in EIS Figure 1.2.

The EARIP HCP describes a conservation program intended to avoid, or minimize and mitigate to the maximum extent practicable, the adverse effects of authorized take of the endangered Texas wild-rice (*Zizania texana*), Comal Springs dryopid beetle (*Stygoparnus comalensis*), Comal Springs riffle beetle (*Heterelmis comalensis*), Peck's Cave amphipod (*Stygobromus pecki*), fountain darter (*Etheostoma fonticola*), San Marcos gambusia (*Gambusia georgei*), Texas blind salamander (*Typhlomolge [=Eurycea] rathbuni*), the threatened San Marcos salamander

(*Eurycea nana*), and the non-listed Edwards Aquifer diving beetle (*Haideoporus texanus*), Texas troglobitic water slater (*Lirceolus smithii*), and Comal Springs salamander (*Eurycea* sp.) (collectively the covered species) in the permit area. The permit area is defined as the jurisdictional area of the EAA, which consists of all or part of Atascosa, Bexar, Caldwell, Comal, Guadalupe, Hays, Medina, and Uvalde Counties (illustrated in Figure 1.2 of the HCP).

The EARIP HCP describes covered activities; including:

1. Edwards Aquifer Authority (EAA):

    a. Programs that implement the statutory functions of the EAA Act, including:

        1. Authorization of withdrawals by persons who are both authorized under the EAA Act and the EAA's rules to withdraw groundwater from the Edwards Aquifer within the jurisdictional boundaries of the EAA.
        2. Authorization of withdrawals from the Edwards Aquifer pursuant to a change in permit under the EAA's permit administration rules in subchapter L of Chapter 711 and for owners and lessees making withdrawals under such a change in permit.
        3. Withdrawals due to the authorization of a "conversion" of "base" water into "unrestricted" water (EAA Rules §§ 711.338-.342) from the irrigator installing water conservation equipment such that less water is required for irrigation of the historically irrigated land (EAA Act § 1.34(b)) or when the historically irrigated lands that provided the basis for the issuance of the Initial Regular Permit have been developed and are no longer farmed under the circumstances described in the EAA rules.
        4. Withdrawals from the Edwards Aquifer pursuant to the Critical Period Management plan described in Section 5.1.4 of the HCP.

    b. The minimization and mitigation measures that the EAA either will implement or for which it bears responsibility for having implemented as identified in Chapter 5 of the HCP.

2. City of New Braunfels:

    a. Recreational activities within the City of New Braunfels's jurisdiction that are facilitated in any respect by the City of New Braunfels, including but not limited to swimming, wading, tubing, boating, canoeing, kayaking, scuba diving, snorkeling, and fishing, in accordance with all applicable laws and regulations (Section 2.3.1 of the HCP).

    b. Management of the ecosystems of the Comal Springs, Landa Lake, and Comal River. The City operates gates, culverts, and dam structures from Landa Lake to the Old Channel (three culverts), New Channel U.S. Geological Survey (USGS) Weir, Springfed Pool Inlet, Wading Pool Weir, Clemens Dam, USGS Weir (known as "Stinky Falls"), Golf Course Weir, and Mill Pond Dam (joint New Braunfels Utility and City of New Braunfels operation) to maintain constant flow in the Comal River, maintain constant elevations of large pools, and regulate flow regimes in the old and new channels during high and low flow events (Sections 2.3.2 and 2.3.3 of the HCP).

c. Diversion of water from the Comal River in accordance with State law. The City of New Braunfels is authorized to divert 8 acre feet per year (9,868 cubic meters per year) of water from the Old Channel and impound it in the pool by TCEQ Permit 18-3826 as a non-consumptive use because the water is returned to the Old Channel (Section 2.3.4 of the HCP).

d. Maintenance and operation of the spring-fed pool (including routine cleaning, algae removal, chemical application pursuant to label instructions, and filling/emptying) in accordance with the HCP (Section 2.3.4 of the HCP).

e. The City of New Braunfels operation of boats on the Comal River and Landa Lake for research, enforcement, litter collection, and maintenance activities (section 2.3.5 of the HCP).

f. The minimization and mitigation measures that the City of New Braunfels will either implement or have responsibility for having implemented as identified in Chapter 5 of the HCP.

3. City of San Marcos:

a. Recreational activities within the City of San Marcos's jurisdiction, including, but not limited to, swimming, wading, tubing, boating, canoeing, kayaking, golfing, snorkeling, SCUBA diving, and fishing, in accordance with all applicable laws and regulations (Section 2.4.of the HCP).

b. The City of San Marcos operation of boats on the San Marcos River and Spring Lake for research, enforcement, litter collection, and maintenance activities (section 2.4.2 of the HCP).

c. Routine, minor repairs of infrastructure and facilities associated with or located on City of San Marcos property that are adjacent to or directly affect the San Marcos Springs and River ecosystem (Section 2.4.3 of the HCP). Routine, minor repairs would include activities such as repairs to access points along the river, but would not involve any activity requiring a U.S. Army Corps of Engineers (USACE) § 404 permit or authorization which may require a section 7 consultation by the USACE.

d. The mitigation and minimization measures that the City of San Marcos will either implement or have the responsibility of implementing as identified in Chapter 5 of the HCP.

4. Texas State University – Covered activities for which incidental take is authorized:

a. Recreational activities within the University's jurisdiction in the San Marcos River and Spring Lake; including but not limited to, swimming, wading, tubing, boating, canoeing, kayaking, golf, diving, snorkeling and fishing, in accordance with all applicable laws and regulations (Section 2.5.1 of the HCP).

b. Educational activities including:

1. Diving for Science Program – trains volunteers to SCUBA in Spring Lake in a manner that protects listed species in order to assist with ecosystem maintenance activities including, but not limited to, algae and litter removal. Participants are required to be under the supervision of the Diving Supervisor, who will be an employee or representative of the Permittee (Texas State University) (Section 2.5.3.1 of the HCP).
2. Continuing Education SCUBA Classes – Use of the Spring Lake designated Dive Training Area (approximately 0.5 acres [2,140 square meters] in size) by Texas State University Continuing Education dive classes for no more than 10 check-out dives per semester. This use is limited to the Dive Training Area (Section 2.5.3.2 in the HCP).
3. Texas State University SCUBA Classes – Texas State University SCUBA classes limited to a maximum of 3 classes per day, with no more than 12 students per class. This use is limited to the Dive Training Area (Section 2.5.3.3 of the HCP).
4. Research activities in Spring Lake, in accordance with all applicable laws and regulations (Section 2.5.4 of the HCP).
5. Texas State University canoeing and kayaking classes in Spring Lake and Sewell Park (Section 2.5.7 of the HCP).

c. Management of the ecosystems of the San Marcos River and Springs, its boating activities in Spring Lake and Sewall Park.

d. The permitted diversion of water from Spring Lake and the San Marcos River in accordance with applicable laws and regulations (Section 2.5.5 of the HCP).

e. Ongoing operation and maintenance of the existing nine-hole University golf course and grounds (section 2.5.6 of the HCP).

e. Minimization and mitigation measures that the University will either implement or have responsibility for implementing as identified in Chapter 5 of the HCP.

5. San Antonio Water System (SAWS) – Covered activities for which incidental take is authorized:

a. Pumping from the Edwards Aquifer and for use and operation of the SAWS ASR (Section 2.6 of the HCP).

b. Minimization and mitigation measures and measures that SAWS will either implement or have responsibility for implementing as identified in Chapter 5 of the HCP.

The EARIP HCP also describes measures intended to minimize and mitigate impacts; and those intended to contribute to the recovery of Covered Species, including:

1. Flow protection measures (minimization measures):

- Critical Period Management (CPM) Program: Implements regulations requiring pumping reductions triggered by identified aquifer and/or springflow levels (Section 5.1.4 of the HCP).
- Use of the SAWS Twin Oaks Aquifer Recharge, Storage, and Recovery Facility (ASR) for Springflow Protection (Section 5.5.1 of the HCP).

2. Measures to protect and manage springflow at Comal Springs and San Marcos Springs (minimization measures):

- Voluntary Irrigation Suspension Program (VISPO): Provides economic incentives to cooperators agreeing to suspend pumping for irrigated agriculture when triggered by identified aquifer levels (Section 5.1.2 of the HCP).
- Regional Water Conservation Program (RWCP): Reduces water demand through installation of high-efficiency plumbing fixtures and economic incentive programs encouraging reduction of lost water, large scale retro-fit, landscape irrigation using treated wastewater, and rain water harvesting (Section 5.1.3 of the HCP).
- SAWS ASR management for Springflow Protection: Provides for 50,000 acre feet (61,674,092 cubic meters) of water storage in the ASR facility for subsequent use to offset pumping cutbacks when triggered by aquifer and springflow levels during drought conditions (Section 5.5.1 of the HCP).

3. Measures to minimize and mitigate impacts to the spring ecosystems (mitigation measures):

   Measures to reduce impacts of drought and enhance viability of the covered species at Comal Springs:

- Restoration and maintenance of native aquatic vegetation (Section 5.2.2 of the HCP).
- Management of river flow between old and new channels of the Comal River (Section 5.2.1 of the HCP).
- Removal of decaying vegetation and dissolved oxygen management (Section 5.2.3 of the HCP).
- Establishment and management of old channel Environmental Restoration and Protection Area (ERPA) (Section 5.2.2.1 of the HCP).
- Management of harmful non-native animal species (Sections 5.2.5 and 5.2.9 of the HCP).
- Monitoring and management of the non-native introduced trematode *Centrocestus formosanus* that parasitizes the fountain darter (Section 5.2.6 of the HCP).
- Restoration of native riparian vegetation (Sections 5.2.8 and 5.7.1 of the HCP).
- Management of public recreational use of the Comal Springs and the Comal River (Section 5.2.3 of the HCP).

Measures to reduce impacts of drought and enhance viability of the covered species at San Marcos Springs:

- Enhancement and restoration of Texas wild-rice (Sections 5.3.1 and 5.4.1 of the HCP).
- Management of public recreation at San Marcos Springs and the San Marcos River (Sections 5.3.2 and 5.4.2 of the HCP).
- Management of aquatic vegetation and litter below Sewell Park (Sections 5.3.3 and 5.4.3 of the HCP).
- Management of non-native plants (Sections 5.3.8 and 5.4.12 of the HCP).
- Management of harmful non-native and predator species (Sections 5.3.9, and 5.4.13 of the HCP).
- Removal of harmful erosion-related sediments below Sewell Park (Section 5.3.6 of the HCP).
- Designation of permanent access points and bank stabilization (Section 5.3.7 of the HCP).
- Restoration of native riparian vegetation (Section 5.7.1 of the HCP).
- Removal of harmful erosion-related sediment in Spring Lake and Sewell Park (Section 5.4.4 of the HCP).
- Removal of harmful erosion-related sand bar in Sessom Creek (Section 5.4.6 of the HCP).
- Management of diving classes in Spring Lake (Section 5.4.7 of the HCP).
- Management of research programs in Spring Lake (Section 5.4.8 of the HCP).
- Management of golf course and grounds (Section 5.4.9 of the HCP).
- Management of boating operations in Spring Lake and Sewell Park (Section 5.4.10 of the HCP).
- Reduction of authorized surface water diversions during low flow periods and intake screen monitoring (Section 5.4.5 of the HCP).

4. Additional measures that contribute to recovery:

- Expanded water quality monitoring program (Section 5.7.5 of the HCP).
- Prohibition of hazardous materials transport across the Comal and San Marcos Rivers and their tributaries (Sections 5.2.7 and 5.3.4 of the HCP).
- Implementation of City of San Marcos household hazardous waste program (Section 5.7.5 of the HCP).
- Implementation of City of San Marcos septic system registration and permitting program (Section 5.7.3 of the HCP).
- Implementation of water quality protection and impervious cover limitation program (Section 5.7.6 of the HCP).
- Management of potentially contaminated runoff (Section 5.7.4 of the HCP).
- Reduction of non-native species introductions (Sections 5.2.9 and 5.3.5 of the HCP).
- Support for refugia efforts at San Marcos Aquatic Resource Center (formerly the San Marcos National Fish Hatchery and Technology Center), Uvalde National Fish Hatchery, and Inks Dam National Fish Hatchery (Section 5.1.1 of the HCP).

5. Adaptive Management Program:

- An extensive adaptive management program focused on testing and addressing uncertainties and improving conservation of the covered species (Chapter 6 of the HCP).

6. Phase II Implementation based on Phase I Adaptive Management:

- Research and Modeling for Phase II Adaptive Management Program (Chapter 6 of the HCP).
- SAWS Presumptive Action incorporating management and operation of the WRIP pipeline (Section 5.5 and Chapter 6 of the HCP).

The Applicants described a two-phased implementation strategy in their HCP. The first phase will be initiated upon permit issuance and includes a variety of minimization and mitigation actions intended to conserve the covered species and their habitats (listed below). These measures will be implemented throughout the duration of the permit. An adaptive management program created to address uncertainty and enhance the effectiveness of the HCP through a process of testing and evaluation will also be initiated upon permit issuance. Phase I adaptive management efforts will focus on testing, collecting information, and continually improving existing and new groundwater, biological, and ecological models. This process will identify and implement modifications to the minimization and mitigation measures to ensure that the Applicants and the measures they enact continue to achieve the biological goals and objectives described in the HCP.

One of the goals of the adaptive management program is to determine if modifying operations and management of the SAWS Twin Oaks Aquifer Recharge, Storage, and Recovery (ASR) facility and Water Resources Integrated Pipeline (WRIP) are necessary to maintain targeted spring flow levels for the protection of the Covered Species.

By a date no later than the eighth anniversary of the issuance of the permit, the second phase of implementation will be initiated. Phase II of the HCP will continue the minimization and mitigation measures implemented during Phase I as modified or supplemented by the adaptive management process, and implement the recommendations regarding the operation and management of the SAWS ASR and WRIP. The adaptive management program will continue to test, evaluate, and adjustments or modifications to ensure that the conservation goals and objectives described in the HCP will be achieved.

The EARIP HCP will compliment other regional conservation efforts in central Texas. Several conservation plans are currently operating or are under development in the region, including the City of Austin's Barton Springs Pool HCP in Travis County, the Balcones Canyonlands Conservation Plan in Travis County, the Hays County Regional HCP, the Williamson County Regional HCP, and a number of plans that are currently under development, including the Barton Springs-Edwards Aquifer HCP, the Comal County Regional HCP, the Southern Edwards Plateau Regional HCP, and a General Conservation Plan for the Golden-cheeked Warbler and the Black-capped Vireo in 33 Central Texas Counties. The operating areas or missions of these and other central Texas programs, however, do not provide incidental take authorization or long-term coordinated conservation for the species and the locations addressed in the EARIP HCP.

All of the species considered in this consultation are affected by water quantity and quality within or flowing from springs of the Edwards Aquifer. These species are therefore dependent upon the management of this natural resource. The following discussion provides a brief description of the Edwards Aquifer, a discussion of water quality and the roles of the agencies responsible for managing this aspect of the resource, and the regulatory context in which the waters of the Aquifer are managed as prescribed by the Texas Legislature and implemented by the EAA.

a. The Edwards Aquifer

The Edwards Aquifer is separated by subsurface groundwater divides into three distinct segments referred to as the Barton Springs, Northern, and Southern (sometimes referred to as the San Antonio) segments (see EIS Figure 3.21). Recharge and water use in the Barton Springs Segment of the Edwards Aquifer is located in northern Hays and portions of Travis County. The Northern Segment of the Edwards Aquifer is located in portions of Travis, Williamson, and Bell Counties. While there is some evidence that under certain specific drought conditions some Southern segment groundwater bypasses San Marcos Springs and flows north into the Barton Springs segment (HDR 2010), it is generally believed that the Barton Springs and Northern segments do not impact flows at Comal Springs and San Marcos Springs (The Edwards Aquifer Area Expert Science Subcommittee for the Edwards Aquifer Recovery Implementation Program 2008). The Barton Springs and Northern segments are therefore not considered further in this consultation.

The Trinity Aquifer stretches across central Texas in a narrow band from the Red River on the Oklahoma border through Hays County and south to Bandera and Medina counties (see EIS Figure 3.19). The Trinity Aquifer recharges slowly, with only about four to five percent of total rainfall within its contributing zone generating recharge in this aquifer system. In some areas, the Trinity Aquifer is overlaid by segments of the Edwards Aquifer and may contribute some recharge to the Edwards Aquifer through faults and fissures (Mace et al. 2000). The extent of the mixing and relationship between these aquifers is poorly understood; though a recent Texas Water Development Board study suggested that as much as 15 percent of the Trinity Aquifer's annual discharge may occur as recharge to the Edwards Aquifer (Anaya and Jones 2009). The importance of Trinity Aquifer recharge to the Edwards Aquifer is not well understood, and the total potential contribution to flows at Comal and San Marcos springs has not been quantified. Given the lack of scientifically or commercially available data, the contributions from the Trinity Aquifer are not considered further in this consultation.

The Southern Segment of the Edwards Aquifer (Edwards Aquifer) falls completely within the Action Area, and is approximately 180 miles (290 km) long and varies from approximately 5 to 40 miles (8 to 64 km) in width. Water within the Edwards Aquifer displays complex and incompletely understood flow patterns, but generally flows from areas of higher elevation in the southwest to areas of lower elevation to the northeast. The Edwards Aquifer is the primary water source for municipal, industrial, agricultural, and domestic uses for more than two million people. The Edwards Aquifer is the source of the springflows, and in some cases the habitats for the considered species, that may be affected by the action considered in this analysis.

The Edwards Aquifer is comprised of three distinct zones referred to as the contributing, recharge, and artesian zones. Each of these zones displays unique hydrogeological characteristics. The contributing zone includes approximately 5,400 square miles (13,986 square kilometers [km]) of catchment basins, creeks, streams, and rivers that flow down-gradient towards the Gulf of Mexico, where they cross the recharge zone. The recharge zone is composed of approximately 1,250 square miles (3,237 square km) of exposed, porous Lower Cretaceous limestones (Brune 1981). Precipitation falling across the contributing zone flows downstream to the recharge zone where it can enter the aquifer through recharge features (such as caves, sinkholes, faults, and fractures) or by infiltrating soils and rock strata that overlie the aquifer. Many creeks, streams, and rivers lose significant amounts and sometimes all of their baseflow to recharge features as they cross the recharge zone. The artesian zone is composed of less permeable geologic layers that confine the inflowing waters from the recharge zone. The hydraulic pressure of the confined water within the artesian zone's cavities, faults, and fissures forces it to the surface where it escapes through numerous springs and seeps.

Near the town of Knippa in central Uvalde County, a geologic formation known as the Uvalde Salient creates an underground barrier to water flow within the saturated strata of the Aquifer. Commonly known as the "Knippa Gap", this physical constriction limits the volume of water flowing down-gradient within aquifer. The Knippa Gap effectively dams water within the upgradient portions of the aquifer to the west of this geologic feature. This has the effect of subdividing this portion of the aquifer into two connected water volumes referred to as the "Uvalde Pool" on the upgradient side of the Knippa Gap and the "San Antonio Pool" on the down-gradient side. Edwards Aquifer wells west of this constriction typically display higher and more stable water levels than wells to the east of this divide. Aquifer management plans recognize this distinction, and regulations that affect pumping are crafted with respect to their effect on the "Uvalde Pool" and the "San Antonio Pool".

The Edwards Aquifer is the source of water for several major and minor springs, including Comal and Hueco springs in Comal County, and San Marcos Springs in Hays County. The Edwards Aquifer has a high capacity for rapid recharge, and rainfall over the contributing and recharge zones can quickly increase water levels within the aquifer. The Edwards Aquifer also experiences rapid drops in water levels due to pumping, especially during drought periods. All of the species addressed in this biological and conference opinion depend on water in or discharged from the springs at Comal or San Marcos springs. The level of the Edwards Aquifer directly affects groundwater and discharge from these springs.

Comal Springs

The Comal Springs system consists of four major spring outlets and several smaller spring runs. The spring runs and Landa Lake form the headwaters of the Comal River, which runs 3.1 miles to its confluence with the Guadalupe River. The average discharge at Comal Springs from 1927 to 2009 was about 291 cubic feet per second (cfs) (8.24 cubic meters per second [cms]). Comal Springs and the Comal River are the sites of designated critical habitat units for three of the species considered in this consultation (Comal Springs dryopid beetle, Comal Springs riffle beetle, and Peck's cave amphipod).

Water flows from Landa Lake into the natural watercourse referred to as the "old channel" and into a man-made "new channel" created in the late 1848 when a dam was constructed to power a gristmill and a sawmill. The two channels rejoin 1.6 miles (2.5 km) downstream (McKinney and Sharp 1995). The old channel retains some of its natural characteristics despite the presence of several small dams and significant channelization. The new channel is uniform in width with a limestone stream bottom in some stretches. Several dams within both the new and old channels of the Comal River serve primarily to provide for recreation accessed from the adjacent parklands and privately owned water recreation facilities (McKinney and Sharp 1995). Bankside construction and development, channel modification, and the natural variability of the springs have affected the aquatic environment of the Comal Springs system over time (BIO-WEST 2007).

There is a strong correlation between specific aquifer levels and cessation of flow from the various Comal Springs outlets. Spring runs #1 and #2 cease flowing when the water elevation in Landa Park Well (a 320-foot [97.5 meter] deep 6-inch [15 centimeter {cm}] diameter observation well above Comal Springs) is approximately 622 feet (189.5 meters) above mean sea level (msl). At this aquifer level spring flow in Comal Springs drops to about 130 cfs (3.68 cubic meters per second). Spring run #3 ceases to flow when the Landa Park Well water level falls to 620 feet (189.0 meters) above msl, which corresponds to the dam-controlled pool level of Landa Lake. At this elevation Comal Springs flow declines to about 50 cfs (1.42 cms) (LBG-Guyton Associates 2004).

The severity of the 1949 to 1956 drought of record (DOR) and its impact on water levels at Landa Lake are unique in the hydrologic record for central Texas. The most critical period of low flow at Comal Springs was during the summer months of 1956, when Landa Lake dropped from "full" in early June, to ceasing flow over the dam in August of that year.

Spring runs #1 and #2 ceased flowing during the summer of 1953 and from the summer of 1954 until January 1957. Spring run #3 stopped flowing during the summer of 1955, and again from May until December in 1956. When the water elevation at the Landa Park well dropped to about 619 feet (188.7 meters) above msl, total spring discharge fell to zero. Spring discharge fell to zero for 144 consecutive days, from June 13 to November 3, 1956. Flow at the new channel dam had stopped at this level, though some water continued to flow through a culvert to the old channel.

Large portions of the lake bottom emerged at a lake elevation of 618 feet (188.3 meters) above msl. The north end of the lake, north of Spring Island, also emerged at about 618 feet (188.3 meters) msl. The lowest level of Landa Park well (613.34 feet [186.9 meters] above msl) was reached August 21, 1956. The deepest pool, just south of Spring Island had a bottom elevation of 613 feet msl, and newspaper clippings describe 6 inches (15.2 centimeters) of water in the deepest pools.

Elevations at the bottom of Landa Lake prevent water from reaching the Old Channel culvert at Landa Park Well water levels of approximately 618 feet (188.3 meters) above msl. Spring discharge could presumably still occur at water levels as low as the lowest lake-bottom elevation of 613 feet [186.9 meters] above msl, though no natural outlets are known from this elevation.

Fern Bank Springs

Fern Bank Springs is located about eight miles northwest of San Marcos Springs and is 0.2 miles (0.3 km) east of the junction of the Blanco River and Sycamore Creek on privately-owned land in a predominately rural landscape. Fern Bank Springs is the site of a designated critical habitat unit for one of the species considered in this consultation (Comal Springs dryopid beetle). Water temperatures at Fern Bank Springs have been reported as ranging between 68 to 71°F (20 to 21.7°C) (George 1952, Brune 1975, Texas Water Development Board 2006).

The spring system consists of a main outlet and a number of small springs that issue forth from a steep cliff overlooking the Blanco River. The exact water source for Fern Bank Springs is unknown, but may derive its flows from the Glen Rose formation of the Trinity Aquifer, from drainage associated with the Edwards Aquifer recharge zone, or from the Blanco River (Veni in litt. 2006). Recent evidence suggests that the water at Fern Bank Springs may be sourced from areas south of the Blanco River (EAA 2010). Fern Bank Springs discharges to the Blanco River just upstream of the Edwards aquifer recharge zone and may provide some small contribution to Edwards aquifer recharge.

Fern Bank Springs discharge is not gaged and has only been intermittently measured. Brune (1981) reported Fern Bank spring flow discharge of 4.9 cfs (0.14 cms) on May 31, 1975, and 0.3 cfs (0.008 cms) on May 1, 1978. A single-family owned the spring site from the late 1800s until 2009, and in 2008, the landowner claimed that the spring never ceased flowing during that time, including through the drought of the 1950s.

Hueco Springs

Hueco Springs (sometimes referred to as Waco Springs) is located in Comal County approximately four miles (6.4 km) north of Comal Springs, and is the site of a designated critical habitat unit for one of the species considered in this consultation (Peck's cave amphipod). This spring complex consists of two main groups of springs issuing from the floodplain of the Guadalupe River. Hueco I is a large, typically perennial spring on the west side of River Road in an undeveloped area. This feature has reportedly stopped flowing during severe drought conditions including the drought of 1984 (Ogden et al. 1986b). Hueco II is an intermittent spring on the east side of River Road that typically stops flowing during the driest months each year (Puente 1976, Barr 1993, Guyton and Associates 1979). Springflow temperatures at Hueco Springs have been reported between 68 to 71°F (20 to 21.7°C) (George 1952, Brune 1975, Texas Water Development Board 2006).

San Marcos Springs

San Marcos Springs is the second largest spring system in Texas and has historically exhibited the greatest flow dependability and environmental stability of any spring system in the southwestern United States. Records indicate that the San Marcos Springs have never ceased flowing, although the flow varies and is tied to fluctuations in the Edwards Aquifer.

The San Marcos Spring system today consists of multiple spring outlets along the shoreline and submerged beneath the surface of Spring Lake. Spring Lake was created when the spring-fed headwaters of the San Marcos River were impounded in 1849 by a dam constructed to operate a gristmill. The surface water and bottom of Spring Lake are owned by the State of Texas, and the State-affiliated Texas State University owns the surrounding lands.

The exact areas contributing recharge to San Marcos Springs have not been clearly delineated. The majority of San Marcos Springs recharge is believed to occur southwest of Comal Springs (Guyton & Associates 1979). The recharge captured in this area is believed to flow beneath Comal Springs before being discharged at San Marcos Springs. The catchment area for these flows are derived from the same sources as the Comal Springs, which likely includes recharge from rivers and creeks north and west of the City of San Antonio. Radioactive isotope analysis of water from the San Marcos Springs indicates that some recharge water also originates from the Dry Comal, Purgatory, York, and Alligator creek basins; and the basins of the Blanco and Guadalupe Rivers (Guyton and Associates, 1979).

The San Marcos River flows primarily southeastward for about 68 miles (109 km) from its impounded headwaters at Spring Lake before joining the Guadalupe River near the city of Gonzales, in Gonzales County. The portion of the river from Spring Lake Dam to the confluence with the Blanco River is referred to as the "upper" San Marcos River, and is about four miles (6.4 km) in length. The upper San Marcos River and Spring Lake are the sites of designated critical habitat units for five of the species considered in this consultation (Texas wild-rice, Comal Springs riffle beetle, fountain darter, San Marcos gambusia, and the San Marcos salamander).

The rapidly flowing and primarily spring-fed San Marcos River is unusually clear and varies from about 16.4 to 49.2 feet (5 to 15 meters) in width and to about 13.1 feet (4 meters) deep. The river flows mostly over gravel or gravel/sand bottom with many shallow riffles alternating with deep pools (Crowe 1994). There is some variability in the substrate, and in areas with lower flows, silt and mud accumulates. Silt dominated substrates are common near eroded banks and stormwater drainage points. The upper San Marcos River is joined by four named and various unnamed creeks, various storm sewer outfalls, and the discharge from a wastewater treatment plant.

Springflows at San Marcos springs are directly related to water use from the Edwards aquifer. The average discharge at San Marcos Springs during the period of record from 1940 to 2009 was approximately 164 cfs (4.64 cms). Much lower flows have occurred during drought conditions. Both the lowest recorded average monthly flow of 54 cfs (1.5 cms) recorded during 1956, and the lowest measured daily flow of 45.5 cfs (1.3 cms) on 15 and 16 August 1956 occurred during the DOR event (Guyton and Associates 1979).

b. Water Quality

Threats to Edwards Aquifer water quality include increases in sedimentation from runoff; cumulative impacts of urbanization (road runoff, leaking sewer lines, residential pesticide and fertilizer use, etc.), groundwater pollution from land-based hazardous material spills and leaking underground storage tanks; and, surface, stormwater, and point and nonpoint source discharges into streams (Seal 1996). As water quantity decreases the spatial distribution of water quality parameters (temperature, pH, turbidity, conductivity, dissolved gases) increase in magnitude in a manner that may negatively impact listed species (Seal and Ellis 1997).

Sediment may affect aquatic organisms in a number of ways. Sediment deposition can physically reduce the amount of available habitat and protective cover for aquatic organisms. Large volumes of sediment can become anoxic (devoid of oxygen) thereby reducing the suitability of affected habitats for covered species. Silt and sediment can also clog the interstitial spaces of the substrates surrounding spring outlets and impact natural substrates downstream (Service 2005).

Pollution and sedimentation of public drinking water sources, including the Edwards Aquifer, are regulated in part under the Federal Safe Drinking Water Act of 1974, as amended. This legislation mandates enforcement of that drinking water standards established by the Environmental Protection Agency (EPA). The Texas Commission on Environmental Quality (TCEQ) is responsible for enforcement of these standards in Texas. The TCEQ requires developers to submit Aquifer protection plans for activities over the contributing, transition, or recharge zones of the Edwards Aquifer, and prohibits facilities such as municipal solid waste landfills and waste disposal wells from being built in the recharge or transition zones.

The TCEQ requires a Water Pollution Abatement Plan (WPAP) for regulated construction activities over the recharge zone. The WPAP must include a geological assessment identifying potential contaminant and sediment pathways to the Aquifer and define the best management practices project proponents will implement to prevent pollution of the Aquifer. Activities that disturb the ground or alter topographic, geologic, or existing recharge characteristics are subject to regulation, which require sediment and erosion controls or a contributing zone plan (CZP) to protect water quality during and after construction. TCEQ provides exemptions including construction of single-family residences on lots larger than five acres in which no more than one single-family residence is located on each lot; agricultural activities; oil and gas exploration, development, and production; clearing of vegetation without soil disturbance; and maintenance of existing structures not requiring additional site disturbance.

The EAA has implemented a water quality protection program that includes well construction rules that regulate the construction, operation, maintenance, abandonment, and closure of wells (EAA Rules Chapter 713, Subchapters B, C, and D). The EAA also regulates the reporting of spills (Subchapter E), storage of certain regulated substances on the recharge zone and the contributing zone (Subchapter F), and installation of tanks on the recharge zone (Subchapter G).

Each year the EAA monitors the quality of water in the Edwards Aquifer by sampling approximately 80 wells, eight surface water sites, and major springs across the region. Tests include measurements of temperature, pH, conductivity, alkalinity, major ions, minor elements (including heavy metals), total dissolved solids, nutrients, pesticides, herbicides, VOCs, and other analytes. Recent EAA testing has not indicated contamination in the Aquifer. However, elevated nitrate detections (greater than two mg/L) were present in 16 of the 79 wells sampled (EAA 2009). The source of these elevated readings is not understood, though agricultural practices, bats, and natural processes have been suggested (Eckhardt 2012). Agricultural practices including the use of nitrate-containing chemical fertilizers are common throughout the region. Nitrate levels generally increase to the west, where a greater proportion of the land area over the aquifer is engaged in agricultural uses. Nitrates can also originate in urban areas. Some scientists have suggested that high nitrate levels could originate from bat guano. There are several bat colonies in caves over the recharge zone of the aquifer. One such feature, known as Bracken Cave, hosts the largest bat colony (Mexican free-tailed bats, *Tadarida brasiliensis*) in the world, estimated to total over 20 million individuals. Bat guano is a well-known nitrate source, and caves in the region have been mined for guano as a source of nitrate for making gunpowder since the time of the Civil War. During recharge events, nitrate-laden guano could be washed into the Edwards Aquifer.

Data gathered by the U.S. Geological Survey (summarized by McKinney and Sharp 1995) show that Comal and San Marcos Springs have little natural variation in water quality. A review of the numbers shows that parameters like temperature, pH, conductivity, total dissolved solids, and major ions generally vary less than 10% and usually less than 5% from the mean. For example, temperature in the San Marcos Springs typically varies less than 0.9° F in the headwaters and only slightly more at the lower end of the spring runs (Guyton & Associates 1979). Vaughan (1986) reported a constant temperature of 70.7° F (21.2°C), with ranges in the streamflow from 77.9° F (25.5°C) in August to 68.7° F (20.39°C) in February at the lower end of the wild-rice zone. Oxygen content reported by Vaughan (1986) was between 5-6 parts per million (ppm). San Marcos springflow pH tends to be neutral or slightly alkaline, which is typical of limestone aquifers (USFWS 1996), and has been reported as 6.9 to 7.9 (TWDB 1968; Vaughan 1986). Whiteside et al. (1994) reported the lowest pH levels at 6.3 in the upper portions of the river and up to 7.9 in the lower stretches.

c. EAA and Management of the Edwards Aquifer

Under the authority of the Texas Water Code (Chapter 36, Subsection 36.101), Texas groundwater conservation districts may limit aquifer withdrawals in accordance with their enabling legislation to conserve, preserve, and protect groundwater or groundwater recharge, and to prevent waste of the groundwater resource or groundwater reservoirs in their jurisdiction as part of a comprehensive, approved groundwater management plan.

An underground water authority, the Edwards Aquifer Authority (EAA), was created (Chapter 626, Laws of the 73rd Texas Legislature, 1993, as amended) to manage and issue permits for the withdrawal of groundwater from the Edwards aquifer for the purposes of water conservation and drought management. The EAA was designated a special regional management district and charged with protecting terrestrial and aquatic life, domestic and municipal water supplies, the operation of existing industries, and the economic development of the State of Texas.

The EAA is mandated to pursue all reasonable measures to conserve water; protect water quality in the aquifer; protect water quality of surface streams provided with springflows from the aquifer; maximize the beneficial use of water available to be drawn from the aquifer; protect aquatic and wildlife habitat; protect threatened and endangered species under Federal or State law; and provide for instream uses, bays and estuaries.

The Texas Legislature directed the EAA in 1993 to limit Edwards Aquifer pumping authorized by permits to a maximum of 450,000 acre feet (555,066,835 cubic meters) per year, and to reduce that total to 400,000 acre feet (493,392,742 cubic meters) per year by December 31, 2007.

During the 2007 legislative session, the Texas Legislature increased the annual maximum amount of pumping that could be authorized by permits to 572,000 acre feet (705,551,621 cubic meters) and directed the EAA to adopt and enforce a "Critical Period Management" (CPM) plan establishing targeted withdrawal reductions during times of drought to achieve the water, species, and species habitat conservation goals established in the agency's enabling legislation (80th Texas Legislature, 2007, Senate Bill 3).

3. Status of the Species and Environmental Baseline

Section 7 requires consultation for actions that may affect species listed as threatened or endangered, and those proposed to be listed as threatened or endangered. A total of 35 species listed as threatened or endangered are known to occur or may be affected by actions that take place within the 17-county action area. Six species currently considered candidates for listing are known to occur, or have distributions which may include counties within the action area. Of these species, 22 that are listed as endangered, four listed as threatened, and three candidate species will not be affected by the action and are therefore not considered further in this consultation (See Table 1).

Species that may be affected by the action include the endangered Texas wild-rice, Comal Springs dryopid beetle, Comal Springs riffle beetle, Peck's cave amphipod, Texas blind salamander, fountain darter, San Marcos gambusia, and the Whooping Crane. Other species that may be affected include the threatened San Marcos salamander and three mussels that are candidates for listing, including golden orb, Texas pimpleback, and Texas fatmucket.

The Applicants elected to include three species that are not listed and which have no regulatory standing at this time as covered species in their HCP. These species are the Texas cave diving beetle, the Texas troglobitic water slater, and the Comal Springs salamander. The Applicants described management activities intended to conserve these species within their HCP, and we therefore include analysis of the effects of the action on these species.

Table 1. Listed and candidate species known to occur within or that may be affected by activities occurring within the Action Area.

Common Name	Scientific Name	Regulatory Status	May be Affected by the action?
black lace cactus	*Echinocereus reichenbachii* var. *albertii*	E	N
Tobusch fishhook cactus	*Sclerocactus brevihamatus* subsp. *tobuschii*	E	N
Texas snowbells	*Styrax platanifolius* subsp. *Texanus*	E	N
Texas wild-rice	*Zizania texana*	E	Y
golden orb	*Quadrula aurea*	C	Y
Texas pimpleback	*Quadrula petrina*	C	Y
Texas fatmucket	*Lampsilis bracteata*	C	Y
Comal Springs dryopid beetle	*Stygoparnus comalensis*	E	Y
Comal Springs riffle beetle	*Heterelmis comalensis*	E	Y
Helotes mold beetle	*Batrisodes venyivi*	E	N
Robber Baron Cave meshweaver	*Cicurina baronia*	E	N
Madla's Cave meshweaver	*Cicurina madla*	E	N
Braken Cave meshweaver	*Cicurina venii*	E	N
Government Canyon Bat Cave meshweaver	*Cicurina vespera*	E	N
Government Canyon Bat Cave spider	*Neoleptoneta microps*	E	N
a cave obligate beetle	*Rhadine exilis*	E	N
a cave obligate beetle	*Rhadine infernalis*	E	N
Cokendolpher Cave Harvestman	*Texella cokendolpheri*	E	N
Austin blind salamander	*Eurycea waterlooensis*	P	N
Barton Springs salamander	*Eurycea sosorum*	E	N
San Marcos salamander	*Eurycea nana*	T	Y
Texas blind salamander	*Typhlomolge (=Eurycea) rathbuni*	E	Y
green sea turtle	*Chelonia mydas*	T	N
hawksbill sea turtle	*Eretmochelys imbricata*	E	N
Kemp's ridley sea turtle	*Lepidochelys kempii*	E	N
leatherback sea turtle	*Dermochelys coriacea*	E	N
loggerhead sea turtle	*Caretta caretta*	T	N
Devils River minnow	*Dionda diaboli*	T	N
fountain darter	*Etheostoma fonticola*	E	Y
San Marcos gambusia	*Gambusia georgei*	E	Y
Northern Aplomado Falcon	*Falco femoralis*	E	N
Piping Plover	*Charadrius melodus*	T	N
Whooping Crane	*Grus americana*	E	Y
Black-capped Vireo	*Vireo atricapilla*	E	N
Golden-cheeked Warbler	*Dendroica chrysoparia*	E	N
Gulf Coast jaguarundi	*Herpailurus yaguarondi calomitli*	E	N
Ocelot	*Leopardus pardalis*	E	N
West Indian manatee	*Trichechus manatus*	E	N

E= endangered; T= threatened; C= candidate for listing as threatened or endangered; P= petitioned to be listed

Species that may be affected by the action are known from the four springs systems or their impoundments described above (Comal Springs and Landa Lake, Fern Bank Springs, Hueco Springs, and San Marcos Springs/Spring Lake), or from the rivers or the estuaries associated with these spring systems (the Comal River, San Marcos River, and the Guadalupe River) (see Figure 3-18 in the EIS). All of these species are not, however, found in all of these locations. Table 2, below, describes the distribution of the species with respect to the springs and river systems.

Table 2. General distribution of species that may be affected.

Species	Comal Springs and Landa Lake	Fern Bank Springs	Hueco Springs	San Marcos Springs and Spring Lake	Comal River	San Marcos River	Guadalupe River
Texas wild-rice							
golden orb							
Texas pimpleback							
Texas fatmucket							
Comal Springs dryopid beetle							
Comal Springs riffle beetle							
Texas cave diving beetle							
Texas troglobitic water slater							
Peck's cave amphipod							
fountain darter							
San Marcos gambusia							
San Marcos salamander							
Texas blind salamander							
Comal Springs salamander							
Whooping Crane							

Following are descriptions of the status, historic and current distribution, reasons for decline and threats to survival, survival needs and recovery criteria, and the status of designated critical habitat for each of the species that may be affected by the action. Factors affecting species within the action area are then described. This includes State, local, and private actions already affecting the species or occurring contemporaneously with this consultation. Unrelated Federal actions affecting the species or their habitats considered here, whether adverse or beneficial, are also described.

Because the entire range of many of the species considered here is wholly contained within the action area, the status of the species also constitutes the environmental baseline for these species.

For those species with ranges that extend beyond the action area, an account of the status within the action area is provided.

a. Texas wild-rice

The entire range of Texas wild-rice (*Zizania texana*) is within the action area, and this species description therefore constitutes the environmental baseline for this species.

Species Description and Life History

Texas wild-rice was listed as endangered on April 26, 1978 (43 FR 17910). Texas wild-rice is an aquatic, monoecious (pistillate and staminate flowers are on the same plant), perennial grass, which is generally 3.3 to 6.6 feet (1 to 2 meters) long and usually immersed and prostrate in the moderate to swift-flowing (0.4 to 3.3 feet [0.12 to 1.0 meters] per second) waters of the San Marcos River (Poole and Bowles 1999, Saunders et al. 2001). Texas wild-rice forms stands at depths from 0.76 to 3.3 feet [0.23 to 1.0 meters] and requires clear, relatively cool, thermally constant (approximately 72°F [22.2°C]) flowing water. Texas wild-rice prefers gravel and sand substrates overlaying Crawford black silt and clay (Poole and Bowles 1999, Saunders et al. 2001; Vaughan 1986).

Spring flow is critical for growth and survival of Texas wild-rice (Saunders et al. 2001). Texas wild-rice relies on carbon dioxide as its inorganic carbon source for photosynthesis rather than the more commonly available bicarbonate used by most other aquatic plants (TPWD 1994; Seal and Ellis 1997). Water from the Edwards Aquifer contains relatively high levels of dissolved carbon dioxide due to the calcium carbonate makeup of the region's karstic geology, and springflows transport the dissolved gas-enriched water downstream.

Reproduction of Texas wild-rice occurs either asexually (clonally) through stolons or sexually via seeds. Asexual reproduction occurs where shoots arise as clones at the ends of rooting stolons (Emery and Guy 1979). Clonal reproduction appears to be the primary mechanism for expansion of established stands, but does not appear to be an efficient mechanism for dispersal and colonization of new areas. Texas wild-rice segments have been observed floating downstream and some of these may become established plants if they become lodged in suitable substrate. Seed production may be essential for dispersal and establishment of new stands of Texas wild-rice.

Texas wild-rice inflorescences, upper culms, and leaves emerge above the water's surface and wind-pollinated florets produce seed during sexual reproduction. This typically takes place in late spring through fall, though flowering and seed set may occur at other times in warm years (Service 1996a). Triggers for flowering are not well understood. Texas wild-rice seed is not long-lived, and viability begins to drop markedly within one year of production. No appreciable seed bank is thought to exist. In slow moving waters, Texas wild-rice can function as an annual. Under these conditions, the species exhibits less robust vegetative growth, then flowers, sets seed, and dies within a single season.

Historic and Current Distribution

The first reported collections of Texas wild-rice from the San Marcos River occurred in 1892 (Terrell et al. 1978). At the time it was described in 1933, the species was reported to be abundant in the San Marcos River, including Spring Lake and its irrigation waterways (Silveus 1933). In 1967 only one plant remained in Spring Lake, none were found in the upper 0.5 miles (0.8 km) of the San Marcos River, and only scattered plants were found in the last 1.5 miles (2.4 km) before the confluence with the Blanco River. No other Texas wild-rice was found (Emery 1967).

Multiple researchers employed different methods and reported varying total coverage of the species from 1975 through 1986, ranging from a low of 2,580 square feet (239.7 square meters) to a high of 12,161 square feet (1,129.8 square meters) (Beaty 1975, Emery 1977, Vaughan 1986). Texas Parks and Wildlife Department (TPWD) began a regular monitoring and reporting effort in June 1989, and has reported coverage ranging from a low of 10,806 square feet (1003.9 square meters) in 1989 to a maximum of 46,042 square feet (4,277.4 square meters) in 2007 (Poole and Bowles 1999, TPWD 2009). Data indicates that while the total areal coverage of Texas wild-rice has generally increased in recent years, the distribution of the species has contracted (Poole 2002). Texas wild-rice is now only found in the upper 1.5 miles (2.4 km) of the upper San Marcos River. The most recent range-wide estimate reported approximately 39,400 square feet (3,660.3 square meters) of Texas wild-rice coverage in the upper San Marcos River and Spring Lake (BIO-WEST 2012). All examples of Texas wild-rice now found in Spring Lake are the result of reintroduction efforts (USFWS 1996b).

Reasons for Decline and Threats to Survival

Reduced springflow has been identified as the greatest threat to Texas wild-rice (Service 1996a). Other threats include natural disasters such as droughts and floods, Texas wild-rice habitat destruction and alteration, non-native species impacts, pollution, and unintended recreational impacts (Service 1996a, Poole et al. 2007).

Though the species was described as abundant in 1933 (Silveus 1933), there are no other records of quantity or distribution of Texas wild-rice before, during, or immediately after the DOR event. The San Marcos River's historic minimum monthly springflows of 54 cfs (1.5 cms) were recorded during the DOR in 1956. The next record of the species is the 1967 description that one plant remained in Spring Lake, and only scattered plants were found in the last 1.5 miles (2.4 km) of the upper San Marcos River (Emery 1967). This decline was attributed to several causes including dredging activities used to maintain the appearance of Spring Lake and the San Marcos River, plant collection, pollution, and the impact of floating debris that damaged the plant's emergent inflorescences thus interfering with reproduction (Emery 1967). It is also likely that reduced springflow during the multi-year DOR event contributed to the decline and reduced range reported in 1967.

Recently observed low flow conditions have resulted in declines in abundance and distribution of Texas wild-rice (TPWD 2009). The species is intolerant of desiccation, and drought conditions that dewater portions of the river (as occurred in 1996) have reportedly killed exposed stands. Low flow events reduce river depth and bring wild-rice plants closer to the water's surface.

Under these conditions, floating mats of vegetation that normally move downriver can become lodged in stands of wild-rice. These mats shade the species and have reportedly interfered with flowering stem emergence, thereby impeding sexual reproduction and seed production believed important for species dispersal (Power 1996, 2002, Poole 2006).

The San Marcos River is located in one of the most flood-prone areas in the United States (Caran and Baker 1986). Though Texas wild-rice evolved in a system exposed to occasional flooding events, scouring floods have been associated with decreasing populations of Texas wild-rice. A flood event in 1998 is reported to have destroyed stands of the species in various segments of the river (Poole 2002, Edwards Aquifer Area Expert Science Subcommittee 2009).

Some research has suggested that Texas wild-rice habitat changes such as altered substrate composition and modified current velocities associated with impoundments and urbanization effects have affected plant biomass production and stem densities (Power 1996). Reductions in streamflow can impact the shallow-growing species by exposing plants to desiccation and increased herbivory by waterfowl and non-native species (Rose and Power 1992).

Texas wild-rice is documented to be consumed by non-native species including nutria (*Myocastor coypus*) and giant ramshorn snails (*Marisa cornuarietis).* Introduced fishes such as suckermouth catfishes (*Loricaridae*) can disrupt substrates thereby increasing turbidity and may burrow into and destabilize riverbanks, thereby introducing additional sediment loads into the river system.

There are numerous non-native plant species in the San Marcos River system that can displace Texas wild-rice through direct competition for space, light and nutrients. It has been suggested that these species may also alter the ecosystem in a manner that reduces habitat suitability for Texas wild-rice. Such species include alligatorweed (*Alternanthera philoxeroides*), giant reed (*Arundo donax*), floating fern (*Ceratopteris thalichtroides*), elephant ear (*Colocasia esculenta*), water trumpet (*Cryptocoryne beckettii*), water-hyacinth (*Eichornia crassipes*), Brazilian waterweed (*Egeria densa*), hydrilla (*Hydrilla verticillata*), dwarf hygrophila (*Hygrophila polysperma*), water milfoil (*Myriophyllum* sp.), water lettuce (*Pistia stratiotes*), and watercress (*Rorippa nasturtium-aquaticum*) (Bowles and Bowles 2001, Poole et al 2007, Rosen 2000).

Texas wild-rice requires clean, flowing waters with adequate concentrations of dissolved carbon dioxide. Pollution such as groundwater contamination or as the result of a catastrophic event such as a hazardous material spill within the watershed or into the San Marcos River itself constitutes another threat to the species. The upper San Marcos River and its immediate tributaries are crossed by a total of 30 bridges, including three railroad bridges and six bridges associated with Interstate Highway 35. Any of these locations could be the source of a spill that could affect Texas wild-rice. Stormwater inflows and other non-point sources of contamination may also pose a threat to the species.

Recreational use of the San Marcos River can also result in adverse impacts to Texas wild-rice. Recreation in the San Marcos River has been reported as seasonal, with the highest use during summer months, holidays and weekends (Bradsby1994). A study that associated recreation activities with visible damage to Texas wild-rice reported that tubing was associated with the greatest individual damage and dogs had the highest level of damage proportional to visits

(Breslin 1997). These studies did not quantify effects to the species at various flow rates; though a greater percentage of the plants are presumably exposed to recreational activities when flow decreases, thereby increasing the potential for adverse impacts.

This environmental baseline describes the current status of the species and is based upon impacts to which the species has been exposed (USFWS and NMFS 1998). To understand the potential effects of the currently authorized and actual pumping amounts as managed by the existing EAA CPM plan, springflow was modeled for a 53-year period (1947 through 2000) that included a range of precipitation conditions including the DOR event that occurred from 1949 to 1956.

When total maximum permitted pumping under current regulations is modeled, San Marcos Springs are projected to cease flowing for 30 consecutive days. For comparison purposes, San Marcos Springs are not reported to have ever stopped flowing, even during the DOR event. This projected model result, though useful in understanding potential effects of the existing aquifer management scheme, does not reflect impacts that the species have experienced because these conditions have not occurred since this management plan was adopted.

Modeling the same 53-year period using actual pumping totals rather than the maximum amount of pumping permitted provides a projection that may more accurately reflect current water use, including increased efficiency of agricultural operations and increased water conservation efforts throughout the region. Actual pumping from 2000 through 2010 averaged 381,000 acre feet (469,956,587 cubic meters) per year. Modeled springflows using this recent average also project a cessation of flow at San Marcos Springs for 30 consecutive days during the repeat of DOR-like conditions (See HCP Table 4-31). This is a modeled result, and the species have not been impacted by the current pumping and management plans because the modeled drought conditions have not occurred since the current management plan was adopted. Figure 1 below replicates Figure 4.2-4 from the EIS illustrating the reported historic springflows and compares the effects of the baseline ("No Action") and the HCP (Alternatives 2a and 2b) action at San Marcos Springs. Further description of this figure is available in Section 4.2 of the EIS.

Survival Needs and Recovery Criteria

The San Marcos and Comal Springs and Associated Aquatic Ecosystems Recovery Plan (Service 1996) identified several recovery criteria for Texas wild-rice, including:

i. Ensuring adequate flows and water quality in Spring Lake and the San Marcos River;
ii. Maintenance of genetically diverse reproductive populations in captivity;
iii. Creation of reintroduction techniques for use in the event of a catastrophic event;
iv. Removal or reduction of local threats from non-native species, recreational users, and habitat alteration; and,
v. Maintenance of healthy, self-sustaining, reproductive populations in the wild.

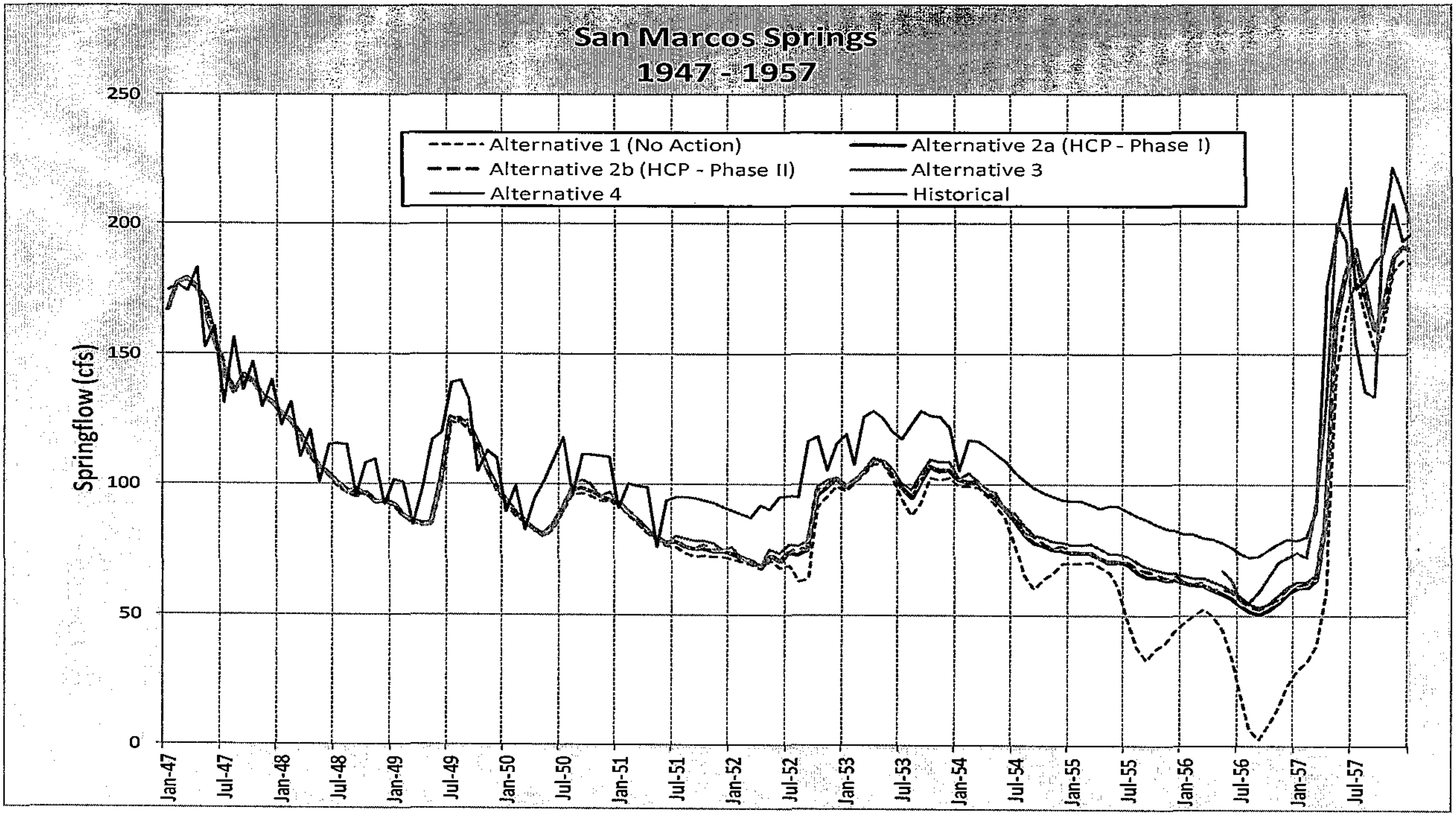

Figure 1. Modeled San Marcos Springs total springflow (reproduced from EIS Figure 4.2-4) illustrating reported historic flows, and comparing the effects of the baseline ("No Action"), and HCP (Alternative 2a and 2b) actions.

Factors affecting the Species within the Action Area

Texas wild-rice has been the subject of eight formal consultations for Federal actions unrelated to the action considered here. The Service consulted with the U.S. Army Corps of Engineers (USACE) for a stormwater outfall and the replacement of two bridges that impacted the San Marcos River. The USACE consulted with the Service on repairs to the main spillway of Spring Lake Dam and an aquatic restoration project at Spring Lake. Two consultations concerned pumping of Edwards Aquifer water by the Department of Defense (DOD) on four military installations in Bexar County. The Service completed an intra-Service consultation regarding the pumping of Edwards Aquifer water that supports the continuing operations and refugia of the San Marcos National Fish Hatchery and Technology Center and the Uvalde National Fish Hatchery.

None of these consultations determined that the considered actions would jeopardize Texas wild-rice or result in destruction or adverse modification of designated critical habitat.

On April 29, 1983, the Texas Parks and Wildlife Commission placed Texas wild-rice on the State endangered list (Texas Register 1983). Section 88.001 of the Texas Parks and Wildlife (TPW) Code and Section 65.171 of the Texas Administrative Code (TAC) prohibit take of an endangered plant for commercial sale from private or public land, except under a State Scientific Research or Non-game Collection Permit. "Take" of an endangered plant is defined in Section 88.001 of the TPW Code as to collect, pick, cut, dig up, or remove. There are no provisions under the Texas Threatened and Endangered Species Regulations for reducing or eliminating the threats that may adversely affect Texas wild-rice or its habitat.

The TPWD is authorized to establish State Scientific Areas for the purposes of education, scientific research, and preservation of flora and fauna of scientific or educational value. To promote conservation of listed species and minimize the impacts of recreational activities on such species and their habitats, TPWD designated a State Scientific Area encompassing a two mile segment of the San Marcos River effective May 1, 2012.

This designation authorizes the State natural resource agency to limit recreation within designated areas when San Marcos River flows fall below 120 cfs (3.4 cms). The designation provides for continued recreational use of the waterway by maintaining open channels outside of protection zones that run the length of the river. These areas allow for continued use of the river even during low flow periods for activities such as tubing, canoeing, kayaking, and swimming.

The regulation makes it unlawful to move, deface, or alter any signage, buoys, booms, or markers delineating the boundaries of the State Scientific Area; to uproot Texas wild-rice within the area; or to enter any such marked areas. The City of San Marcos and Texas State University have committed to install kiosks at key locations identifying access points, exclusion areas, and to provide educational information about the State Scientific Area and the species and their habitats it is intended to conserve.

Because the designated State Scientific Area in the San Marcos River has only recently been established, no information has yet been collected concerning effects to listed species including Texas wild-rice.

Critical Habitat

Texas wild-rice critical habitat was designated on July 14, 1980, and is described as Spring Lake and the San Marcos River downstream to its confluence with the Blanco River (45 FR 47355). All designated critical habitat for Texas wild-rice is contained within the action area considered in this consultation.

The rule-making for Texas wild-rice predates the October 1, 1984, regulation (49 FR 38900) stipulating that primary constituent elements (PCEs) essential for the conservation of the species be identified at the time critical habitat is designated. However, the rule describes actions that would adversely modify designated critical habitat, including those that would significantly alter the flow or water quality in the San Marcos River; physically alter Spring Lake or the San Marcos River, such as dredging, bulldozing, or bottom plowing; or physically disturb the plants, such as harrowing, cutting, or intensive collecting. Based on the best available scientific and commercial data available, the primary constituent elements could generally be defined as:

i. Clear water,
ii. Uniform annual flow rate,
iii. Constant year-round temperature, and
iv. Maintenance of the natural substrate.

Clear water is currently available in the designated critical habitat for Texas wild-rice under most conditions. Activities that contribute sediment loads, such as non-point source erosion from the urbanizing areas surrounding the upper San Marcos River, or activities that suspend existing sediments such as lake bottom disturbances by SCUBA divers in Spring Lake or swimmers in the San Marcos River, can increase turbidity and impact this element. Such turbidity in Spring Lake and the San Marcos River usually dissipate as the suspended particulates flow downstream or settle out of the water column in relation to flow rate. Continual or repeated re-suspension of particulates can markedly reduce water clarity. This can be observed downstream of popular recreation sites in the river during periods of intense use, such as weekends and holidays.

Flow rate is the result of precipitation and recharge that contribute to aquifer levels as they are affected by pumping throughout the region. Current aquifer management regulations limit pumping during drought conditions by specified amounts triggered by index well levels and springflows. These mechanisms have maintained continual springflows since they were enacted, though drought conditions during this time period have not approached the severity and duration of the DOR. As described above, existing authorized pumping volumes and regulatory schemes are not expected to provide continual springflow during a repeat of DOR-like conditions.

Temperature at San Marcos Springs reportedly varies less than 0.9° F (0.5°C) near the headwater springs (Guyton and Associates 1979). Vaughan (1986) reported a constant springflow temperature of 70.7° F (21.5°C), with temperature ranges of 68.7° F in February to 77.9° F (20.4 to 25.5°C) in August at the most downstream extent of occupied Texas wild-rice habitat in the San Marcos River.

Substrates within the designated critical habitat for Texas wild-rice have been affected by sedimentation related primarily to urbanization effects within the upper San Marcos River watershed. Sediment bars have been created within the river channel just downstream of Spring Lake dam and within the river segment that runs through Sewell Park as a result of these impacts. Substrates in portions of the designated critical habitat maintain a more natural character.

b. Golden orb

The range of the golden orb (*Quadrula aurea*) extends beyond the action area, and this species description therefore describes both the rangewide status as well as a discussion of those populations that may be affected by the proposed action.

Species Description and Life History

The golden orb is a freshwater mussel in the family Unionidae, usually less than 3.2 inches (8.1 cm) in length, with an oval to nearly round, smooth shell, unsculptured except for concentric growth rings (Howells et al. 1996, 2002). External shell coloration varies from yellow-brown, gold, or orange-brown to dark brown or black, and some individuals may show faint greenish rays (Howells 2002).

Golden orbs have distinct male and female forms. During reproduction, males release clouds of sperm into the water column, which females draw in through their siphons. Fertilization takes place internally, and the resulting eggs develop into specialized larvae (called glochidia) within the female gills. Gravid females have been found from May through August (Howells 2000). Mussels in the genus *Quadrula* are termed short-term brooders because they hold fertilized eggs and glochidia for a short period, usually 3 to 6 weeks, before releasing glochidia into the water column (Gorden and Layzer 1989, Garner *et al.* 1999).

The glochidia of freshwater mussels are obligate parasites (cannot live independently of their hosts) on the gills or fins of fishes (Vaughn and Taylor 1999). Glochidia die if they fail to find a host fish, attach to a fish that has developed immunity from prior infestations, or attach to the wrong location on a host fish (Neves 1991, Bogan 1993). Glochidia encyst (enclose in a cyst-like structure) on the host's tissue and develop into juvenile mussels weeks or months after attachment (Arey 1932).

The primary mechanism of dispersal occurs as glochidia attach to host fishes which transport the species within the water body (Smith 1985). Upon release from the host, newly transformed juveniles drop to the substrate on the bottom of the stream. Juveniles that drop in unsuitable substrates die because their immobility prevents them from relocating to more favorable habitat. Juvenile freshwater mussels burrow into interstitial substrates and grow to a larger size that is less susceptible to predation and displacement from high flow events (Yeager *et al.* 1994). Throughout the rest of their life cycle, mussels generally remain within the same small area where they released from the host fish.

For the first several months after releasing from their host fishes, juvenile mussels inhabit interstitial spaces (small spaces between sediment particles) within the substrate and feed on suspended and depositional material such as algae and detritus (Yeager *et al.* 1994).

Adult golden orbs are suspension feeders, drawing in food and oxygen through their incurrent siphon (tube that draws water into the shell). They may also feed on organic particles in sediment using the large, muscular foot (an organ used to anchor the mussel in the substrate or for locomotion) (Raikow and Hamilton 2001). Adults feed on algae, bacteria, detritus (dead organic material), microscopic animals, and dissolved organic matter (Fuller 1974, Silverman *et al.* 1997, Nichols and Garling 2000, Christian *et al.* 2004).

There is no specific information on age, size of maturity, or host fish use for the golden orb. Other species in the genus *Quadrula* successfully parasitize catfish, and it is likely golden orbs do so as well (Howells 2010a). This species is found in substrates of firm mud, sand, and gravel, and it does not appear to tolerate more unstable substrates such as loose sand or silt (Howells 2002).

Historic and Current Distribution

The golden orb is known to have occurred in the Guadalupe, San Antonio, and Nueces River basins (Howells 2010a). Data indicate that the golden orb has declined significantly throughout its former range and is now known from nine disjunct locations in four streams. Since 1995 the golden orb has only been found in the Guadalupe, lower San Marcos, and lower San Antonio Rivers and Lake Corpus Christi (an impoundment of the lower Nueces River). Of the nine known populations, four appear to be relatively stable and recruiting, while the remaining populations are represented by only a few individuals.

Golden orb was known from Live Oak County in the Nueces River Basin (OSUM 2011a) but appears to have been extirpated with the exception of a remnant population that occurs in a reservoir (Lake Corpus Christi) on the lowermost portions of the basin. While the species does not typically inhabit lentic (ponded) water, wave action is presumed to simulate flowing water conditions and has supported a golden orb population since at least the 1970s (OSUM 2011a). A drawdown of the lake in 1996 resulted in stranding and death of large numbers of the species (Howells 2010a). A small golden orb population likely persists in the reservoir (Howells 2006).

Within the Action Area considered in this consultation, the golden orb is known today primarily from four stable and reproducing populations in the lower portion of the Guadalupe River basin (within approximately 75 miles [120 km] of the Gulf of Mexico), and a few scattered remnant populations. Of these small populations, only those in the middle Guadalupe River and lower San Marcos River are likely connected; the remaining extant populations are highly fragmented and restricted to short reaches.

Reasons for Decline and Threats to Survival

The primary threat to the golden orb has been described as habitat destruction and modification from impoundments (76 FR 62166). Impoundments scour riverbeds, thereby removing mussel habitat, decrease water quality, modify stream flows, and restrict fish host migration and distribution of freshwater mussels.

Other threats include sedimentation, dewatering, sand and gravel mining, and chemical contamination. These threats may be exacerbated by climate change, fragmentation and isolation of remnant populations, and the potential threats arising from the introduction of nonnative species (76 FR 62166).

The status of the species described here is based upon impacts to which the species has been exposed. To understand the potential effects of the currently authorized and actual pumping amounts as managed by the existing EAA CPM plan, springflow was modeled for a 53-year period (1947 through 2000) that included a range of precipitation conditions including the DOR event that occurred from 1949 to 1956.

When total maximum permitted pumping under current regulations is modeled, Comal Springs are projected to cease flowing for 38-months and San Marcos Springs are projected to stop flowing for 30 consecutive days. For comparison, during the 1949 to 1956 DOR, Comal Springs ceased flowing for four-months, and San Marcos Springs are not recorded to have ever stopped flowing. This projected model result, though useful in understanding potential effects of the existing aquifer management scheme, does not reflect impacts that the species have experienced because these conditions have not occurred since this management plan was adopted. Figure 1 (above) illustrates the reported historic springflows and compares the effects of the baseline ("No Action") and the HCP (Alternatives 2a and 2b) action at Comal Springs. Further description of this figure is available in Section 4.2 of the EIS.

Modeling the same 53-year period using actual pumping totals rather than the maximum amount of pumping permitted provides a projection that may more accurately reflect current water use, including increased efficiency of agricultural operations and increased water conservation efforts throughout the region. Actual pumping from 2000 through 2010 averaged 381,000 acre feet (469,956,586 cubic meters) per year. Modeled Comal springflows using this recent average projects that Comal Springs will cease flowing for 36-months, and San Marcos springflows stop flowing for 30 consecutive days during a repeat of DOR-like conditions (See HCP Table 4-30 and 4-31). This is a modeled result, and the species have not been impacted by the current pumping and management plans because the modeled drought conditions have not occurred since the current management plan was adopted. Figure 2 below replicates Figure 4.2-2 from the EIS that illustrates the reported historic springflows and compares the effects of the baseline ("No Action") and the HCP (Alternatives 2a and 2b) action at Comal Springs. Further description of this figure is available in Section 4.2 of the EIS.

Because Comal and San Marcos springflows are the primary or significant contributors of water volume to the San Marcos and Guadalupe Rivers, the reduction and loss of springflows projected by these modeling efforts during severe drought conditions could have significant impacts to the species within the action area.

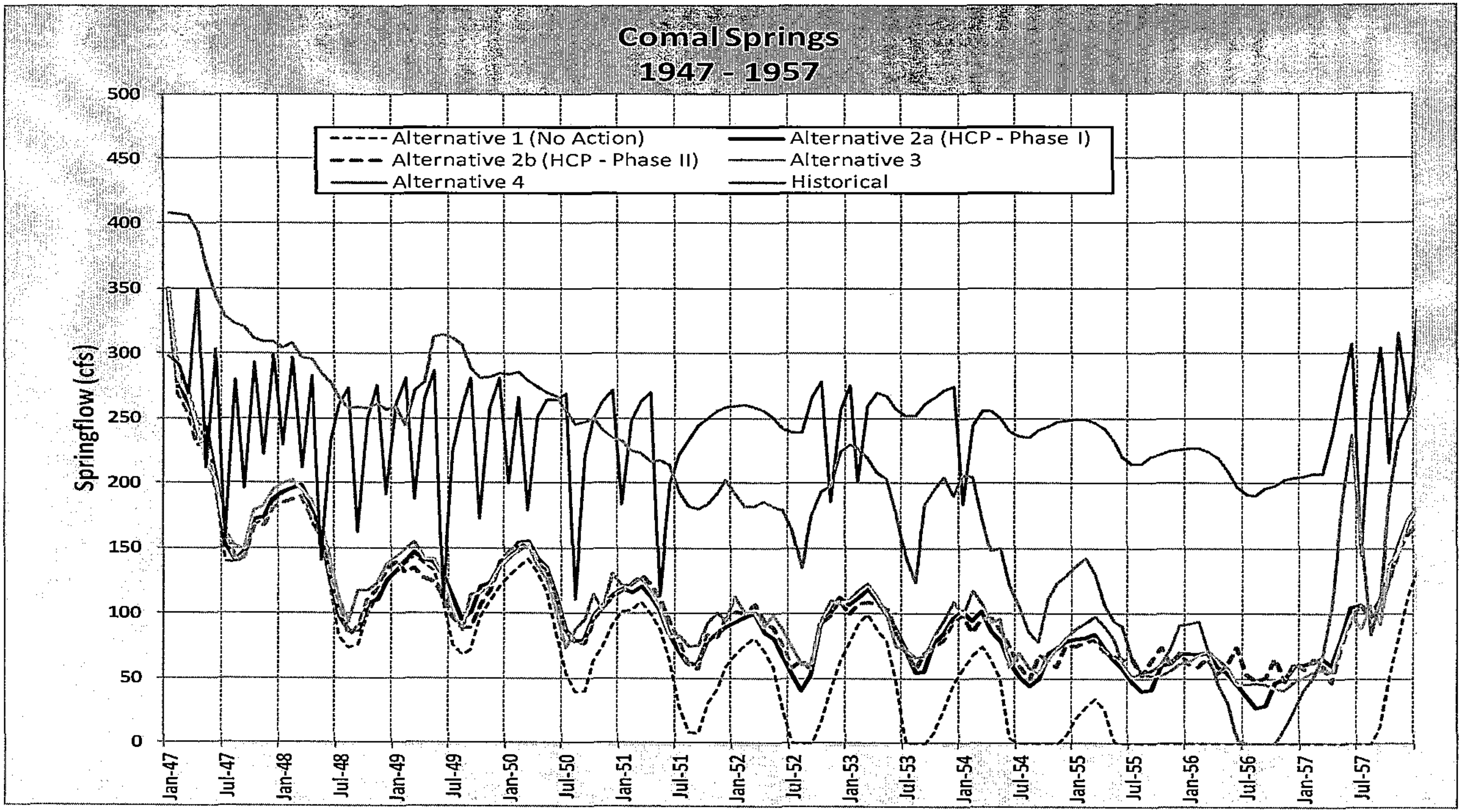

Figure 2. Modeled Comal Springs total springflow (reproduced from EIS Figure 4.2-2) illustrating reported historic flows, and comparing the effects of the baseline ("No Action"), and HCP (Alternative 2a and 2b) actions.

Survival Needs and Recovery Criteria

Because this species has not been listed, no recovery criteria have been established. Survival needs could generally be characterized as maintenance of remaining habitat areas; restoration and maintenance of suitable habitat areas that may continue to provide physical and biological factors necessary for the breeding, feeding, and sheltering needs of the species; reduction of threats posed by dewatering, sand and gravel mining, the introduction of non-native species, and degradation of water quality due to sedimentation and chemical contamination.

Factors affecting the Species within the Action Area

No consultations that consider potential impacts to this species have been completed.

On January 8, 2010, the Texas Parks and Wildlife Commission placed the golden orb on the State list of threatened species (Texas Register 2010). Section 68.002 of the TPW Code and Section 65.171 of the TAC prohibit take of a threatened species, except under a State Scientific Research or Non-game Collection Permit. ''Take'' is defined in Section 1.101(5) of the TPW Code as to collect, hook, hunt, net, shoot, or snare, by any means or device, and includes an attempt to take or to pursue in order to take. There are no provisions under the Texas Threatened and Endangered Species Regulations for reducing or eliminating the threats that may adversely affect the golden orb or its habitat.

Critical Habitat

The golden orb is currently a candidate for listing as threatened or endangered, therefore no critical habitat has been designated for this species.

c. Texas pimpleback

The range of the Texas pimpleback (*Q. petrina*) extends beyond the action area, and this species description therefore describes both the rangewide status as well as a discussion of those populations that may be affected by the proposed action.

Species Description and Life History

The Texas pimpleback is a large freshwater mussel with a moderately thick and inflated shell that generally reaches 2.4–3.5 in (6.1 to 8.9 cm) (Howells 2002). With the exception of growth lines, the shell of the Texas pimpleback is generally smooth (Howells 2002). External coloration ranges from yellowish-tan to dark brown with some individuals mottled or with dark green rays.

There is very little specific information on age, size of maturity, or host fish use for Texas pimpleback. Gravid females have been found from June through August, and the smallest documented gravid female was 1.8 in long (Howells 2000). Glochidia are hookless and elliptical in shape (Howells *et al.* 1996). To date, no host fish have been confirmed for the Texas pimpleback; however, glochidia have been reported attached to and encysted on flathead catfish

(*Pylodictis olivaris*), yellow bullhead (*Ameiurus natalis*), and bluegill (*Lepomis macrochirus*) in laboratory settings, although none transformed to the juvenile stage (Howells 2010c). This is consistent with other species in the genus *Quadrula,* which also parasitize catfish species.

The Texas pimpleback typically occurs in moderately sized rivers, usually in mud, sand, gravel, and cobble, and occasionally in gravel-filled cracks in bedrock slab bottoms (Horne and McIntosh 1979; Howells 2002). The species has not been found in depths greater than 6.6 ft (2.0 meters). Texas pimplebacks have not been found in reservoirs, which indicate that this species is intolerant of deep, low velocity waters created by artificial impoundments (Howells 2002). Texas pimplebacks appear to tolerate faster water more than many other mussel species (Horne and McIntosh 1979).

Historic and Current Distribution

The Texas pimpleback is endemic to the Colorado and Guadalupe-San Antonio River basins of central Texas (Howells 2002). In the Colorado River basin, the Texas pimpleback occurred throughout most of the mainstem, as well as numerous tributaries, including the Concho, North Concho, San Saba, Llano, and Pedernales Rivers; and Elm and Onion Creeks (Howells 2010c, Randklev *et al.* 2010c, OSUM 2011b). The species occurred throughout most of the Guadalupe River, as well as in the San Antonio, San Marcos, Blanco, and Medina Rivers (Horne and McIntosh 1979, Howells 2010c, OSUM 2011b). The Texas pimpleback has declined significantly rangewide, and only four streams—the San Saba River, Concho River, Guadalupe River, and San Marcos River—are known to harbor persisting populations of the species. These populations are disjunct, small, and isolated. The species has been extirpated from the remainder of its historical range (76 FR 62166).

Only two populations appear large enough to be stable, and evidence of recruitment in the Concho River population is limited. The San Saba River population may be the only remaining recruiting population of Texas pimpleback. The remaining populations in the San Marcos and Guadalupe Rivers are represented by very few individuals (76 FR 62166).

Reasons for Decline and Threats to Survival

The reduction in numbers and range of the Texas pimpleback is primarily the result of the long-lasting effects of habitat alterations such as the effects of impoundments, sedimentation, sand and gravel mining, and chemical contaminants (76 FR 62166). Impoundments occur throughout the range of the species and have far-reaching effects both up and downstream. The Colorado and Guadalupe River systems have both experienced a large amount of sedimentation from agriculture, instream mining, and urban development. Sand and gravel mining affects Texas pimpleback habitat by increasing sedimentation and channel instability downstream and causing headcutting upstream. Chemical contaminants have been documented throughout the range of the species and may represent a significant threat to the Texas pimpleback.

The effects of climate change, while difficult to quantify at this time, are likely to exacerbate the current and ongoing threat of habitat loss caused by other factors, and the small sizes and fragmented nature of the remaining populations render them more vulnerable to extirpation. In addition, nonnative species, such as golden algae, threaten the species, and the potential introduction of zebra mussels and black carp are potential future threats (76 FR 62166).

The status of the species described here is based upon impacts to which the species has been exposed. To understand the potential effects of the currently authorized and actual pumping amounts as managed by the existing EAA CPM plan, springflow was modeled for a 53-year period (1947 through 2000) that included a range of precipitation conditions including the DOR event that occurred from 1949 to 1956.

When total maximum permitted pumping under current regulations is modeled, Comal Springs are projected to cease flowing for 38-months and San Marcos Springs are projected to stop flowing for 30 consecutive days. For comparison, during the 1949 to 1956 DOR, Comal Springs ceased flowing for four-months, and San Marcos Springs are not recorded to have ever stopped flowing. This projected model result, though useful in understanding potential effects of the existing aquifer management scheme, does not reflect impacts that the species have experienced because these conditions have not occurred since the current management plan was adopted.

Modeling the same 53-year period using actual pumping totals rather than the maximum amount of pumping permitted provides a projection that may more accurately reflect current water use, including increased efficiency of agricultural operations and increased water conservation efforts throughout the region. Actual pumping from 2000 through 2010 averaged 381,000 acre feet (469,956,586 cubic meters) per year. Modeled Comal springflows using this recent average projects that Comal Springs will cease flowing for 36-months, and San Marcos springflows stop flowing for 30 consecutive days during a repeat of DOR-like conditions (See HCP Table 4-30 and 4-31). This is a modeled result, and the species have not been impacted by the current pumping and management plans because the modeled drought conditions have not occurred since the current management plan was adopted. Figures 1 and 2 (above) illustrate the reported historic springflows and compare the effects of the baseline ("No Action") and the HCP (Alternatives 2a and 2b) action at San Marcos Springs and Comal Springs, respectively. Further description of these figures is available in Section 4.2 of the EIS.

Because Comal and San Marcos springflows are the primary or significant contributors of water volume to the San Marcos and Guadalupe Rivers, the reduction and loss of springflows projected by these modeling efforts during severe drought conditions could have significant impacts to remaining Texas pimpleback mussels in these locations.

Survival Needs and Recovery Criteria

Because this species has not been listed, no recovery criteria have been established. Survival needs could generally be characterized as maintenance of remaining habitat areas; restoration and maintenance of suitable habitat areas that may continue to provide physical and biological factors necessary for the breeding, feeding, and sheltering needs of the species; reduction of threats posed by dewatering, sand and gravel mining, the introduction of non-native species, and degradation of water quality due to sedimentation and chemical contamination.

Factors affecting the Species within the Action Area

No other consultations addressing potential impacts to this species have been completed.

On January 8, 2010, the Texas Parks and Wildlife Commission placed 15 species of freshwater mussels, including the Texas pimpleback, on the State threatened list (Texas Register 2010). Section 68.002 of the TPW Code and Section 65.171 of the TAC prohibit take of a threatened species, except under a State Scientific Research or Non-game Collection Permit. ''Take'' is defined in Section 1.101(5) of the TPW Code as to collect, hook, hunt, net, shoot, or snare, by any means or device, and includes an attempt to take or to pursue in order to take. There are no provisions under the Texas Threatened and Endangered Species Regulations for reducing or eliminating the threats that may adversely affect Texas pimpleback or its habitat.

Critical Habitat

Because the Texas pimpleback is currently a candidate for listing as threatened or endangered, there is no designated critical habitat for this species.

d. Texas Fatmucket

The range of the Texas fatmucket (*Lampsilis bracteata*) extends beyond the action area, and this species description therefore describes both the rangewide status as well as a discussion of those populations that may be affected by the proposed action.

Species Description and Life History

The Texas fatmucket is a large, elongated freshwater mussel that reaches a maximum length of 3.94 inches (10.0 cm) (Howells 2010b). The shell is oval to elliptical or somewhat rhomboidal and tan to greenish-yellow with numerous irregular, wavy, and broad and narrow dark brown rays, with broad rays widening noticeably as they approach the ventral (underside) margin. The nacre is white with occasional yellow or salmon coloration and iridescent posteriorly (Howells 2010b). Females have mantle flaps (extensions of the tissue that covers the visceral mass) that often resemble minnows (Howells 2010b).

The Texas fatmucket occurs in moderately sized rivers in mud, sand, or gravel, or mixtures of these substrates (Howells 2010b) and sometimes in narrow crevices between bedrock slabs (Howells 1995). Live individuals have been found in relatively shallow water, rarely more than 4.9 feet (1.5 meters) deep.

Remaining populations typically occur at sites where one or both banks are relatively low, allowing floodwaters to spread out over land and thereby reducing damage from scouring (Howells 2010b). The species does not occur in ponds, lakes, or reservoirs, suggesting that it is intolerant of the deep, low-velocity water created by artificial impoundments (76 FR 62166).

Historic and Current Distribution

The Texas fatmucket historically had populations in at least 18 rivers in the upper Colorado, Guadalupe, and San Antonio River systems in the Texas Hill Country and east-central Edwards Plateau region of central Texas. In the Colorado River, it ranged from Travis County upstream approximately 200 miles (322 km) to Runnels County (76 FR 62166).

It was also found in many tributaries, including the Pedernales, Llano, San Saba, and Concho Rivers, and Jim Ned, Elm, and Onion Creeks (Howells *et al.* 1996). In the Guadalupe-San Antonio River basin, the Texas fatmucket occupied approximately 150 miles (241 km) of the Guadalupe River, from Gonzales County upstream to Kerr County, including the North Guadalupe River, Johnson Creek, and the Blanco River. In the San Antonio River, it ranged from its confluence with the Medina River in Bexar County upstream to the City of San Antonio, as well as in the Medina River and Cibolo Creek (Howells *et al.* 1996; Howells 2010b).

Based on historical and current data, the Texas fatmucket has declined significantly rangewide and is now known from only nine streams in the Colorado and Guadalupe River systems. All existing populations are represented by only one or two individuals and are likely not stable or recruiting (juvenile mussels joining the adult population). In the streams where the species survives, populations are highly fragmented and usually restricted to short reaches (76 FR 62166).

Based on historical and current data, the Texas fatmucket has been extirpated from most of the Guadalupe River system and hundreds of miles of the Colorado River, as well as from numerous tributaries. Two of the populations considered extant in recent years may now be extirpated, and the remaining seven populations are extremely small and likely not stable. No evidence of recent recruitment has been found in any of the populations, with the possible exception of the Llano River (76 FR 62166).

Reasons for Decline and Threats to Survival

The reduction in distribution and abundance of the Texas fatmucket is primarily the result of the long-lasting effects of habitat alterations (76 FR 62166). This includes the effects of impoundments, sedimentation, dewatering, sand and gravel mining, and chemical contamination. Impoundments occur throughout the range of the species and can have far-reaching effects both up- and downstream, such as riverbed scouring that removes mussel habitat, decreases water quality, modifies stream flows, and prevents fish host migration and therefore distribution of freshwater mussels. Both the Colorado and Guadalupe River systems have experienced a large amount of sedimentation from agriculture, mining, urban development, and widespread Ashe juniper (*Juniperus ashei*) removal. Sand and gravel mining affects Texas fatmucket habitat by increasing sedimentation and channel instability downstream and causing upstream headcutting. Chemical contaminants have been documented throughout the range of the species and are a significant concern to Texas fatmucket.

Texas fatmucket populations may already be below the minimum viable population requirement, which would cause a reduction in the number of populations and an increase in the species' vulnerability to extinction. These threats may exacerbated by climate change, which may increase the frequency and magnitude of droughts. In addition, nonnative species, such as golden algae, currently threaten the Texas fatmucket, and the potential introduction of non-native species such as zebra mussels and black carp represents an additional threat (76 FR 62166).

The status of the species described here is based upon impacts to which the species has been exposed. To understand the potential effects of the currently authorized and actual pumping amounts as managed by the existing EAA CPM plan, springflow was modeled for a 53-year period (1947 through 2000) that included a range of precipitation conditions including the DOR event that occurred from 1949 to 1956.

When total maximum permitted pumping under current regulations is modeled, Comal Springs are projected to cease flowing for 38-months and San Marcos Springs are projected to stop flowing for 30 consecutive days. For comparison, during the 1949 to 1956 DOR, Comal Springs ceased flowing for four-months, and San Marcos Springs are not recorded to have ever stopped flowing. This projected model result, though useful in understanding potential effects of the existing aquifer management scheme, does not reflect impacts that the species have experienced because these conditions have not occurred since this management plan was adopted.

Modeling the same 53-year period using actual pumping totals rather than the maximum amount of pumping permitted provides a projection that may more accurately reflect current water use, including increased efficiency of agricultural operations and increased water conservation efforts throughout the region. Actual pumping from 2000 through 2010 averaged 381,000 acre feet (469,956,586 cubic meters) per year. Modeled Comal springflows using this recent average also projects that Comal Springs will cease flowing for 36-months, and San Marcos springflows stop flowing for 30 consecutive days during a repeat of DOR-like conditions (See HCP Table 4-30 and 4-31). This is a modeled result, and the species have not been impacted by the current pumping and management plans because the modeled drought conditions have not occurred since the current management plan was adopted. Figures 1 and 2 (above) illustrate the reported historic springflows and compare the effects of the baseline ("No Action") and the HCP (Alternatives 2a and 2b) action at San Marcos Springs and Comal Springs, respectively. Further description of these illustrations is available in Section 4.2 of the EIS.

Because Comal and San Marcos springflows are significant contributors of water volume to the Guadalupe River, the reduction and loss of springflows projected by these modeling efforts during severe drought conditions could have significant impacts to remaining Texas fatmucket mussels in the Guadalupe River system.

Survival Needs and Recovery Criteria

Because this species has not been listed, no recovery criteria have been established. Survival needs could generally be characterized as maintenance of remaining habitat areas; restoration and maintenance of suitable habitat areas that may continue to provide physical and biological factors necessary for the breeding, feeding, and sheltering needs of the species; reduction of threats posed by dewatering, sand and gravel mining, the introduction of non-native species, and degradation of water quality due to sedimentation and chemical contamination.

Factors affecting the Species within the Action Area

No other consultations addressing potential impacts to this species have been completed.

On January 8, 2010, the Texas Parks and Wildlife Commission placed the Texas fatmucket on the State threatened list (Texas Register 2010). Section 68.002 of the TPW Code and Section 65.171 of the TAC prohibit take of a threatened species, except under a State Scientific Research or Non-game Collection Permit. "Take" is defined in Section 1.101(5) of the TPW Code as to collect, hook, hunt, net, shoot, or snare, by any means or device, and includes an attempt to take or to pursue in order to take. There are no provisions under the Texas Threatened and Endangered Species Regulations for reducing or eliminating the threats that may adversely affect Texas fatmucket or its habitat.

The TPWD designated specific areas of streams and reservoirs as no harvest mussel sanctuaries (31 TAC, part 2, chapter 57, subpart B, Rule 57.157). The locations of the designated mussel sanctuaries were selected because they support populations of rare and endemic mussel species or are important for maintaining, repopulating, or allowing recovery of mussels in watersheds where they have been depleted. As a result of the designation of mussel sanctuaries, four of the Texas fatmucket populations are protected from harvesting disturbance of other species (Howells 2010d). The State's mussel sanctuary regulations are limited to restricting harvest activities and do not address other activities that may affect mussels or their habitats. The State threatened and mussel sanctuary designations do not provide regulatory mechanisms to protect Texas fatmucket from habitat alteration or other threats.

Critical Habitat

Because the Texas pimpleback is currently a candidate for listing as threatened or endangered, there is no designated critical habitat for this species.

e. Comal Springs dryopid beetle

The entire range of the Comal Springs dryopid beetle (*Stygoparnus comalensis*) is within the action area, and this species description therefore constitutes the environmental baseline for this species.

Species Description and Life History

The Comal Springs dryopid beetle was listed as endangered on December 18, 1997 (62 FR 66295). The only known hypogean- (subterranean) adapted member of the family Dryopidae, the species was described based on its unique morphological distinctions including vestigial (poorly developed and non-functioning) eyes and wings (Barr and Spangler 1992).

Larvae are elongate, cylindrical, and yellowish-brown in color, and reach approximately 0.24 to 0.31 inches (6.0 to 7.8 millimeters [mm]) in length (Barr and Spangler 1992). Larvae in the family Dryopidae do not have gills and are considered terrestrial, inhabiting moist soil along stream banks (Brown 1987, Ulrich 1986). The presence of vestigial eyes indicates adaptation to subterranean habitats. Larval development is unknown and pupae for this species have not been described.

Adult Comal Springs dryopid beetles are elongate, parallel-sided and slender, with retractile head and translucent reddish-brown cuticle (Barr and Spangler 1992). Habitat for the Comal Springs dryopid beetle has been described as the soil, roots, and debris exposed above the waterline on the ceilings of spring orifices (Barr and Spangler 1992). Though restricted to aquatic environments by their reliance on a plastron for respiration (a gas film produced by an area of dense water-repelling hairs), adult Comal Springs dryopid beetles cannot swim (Brown 1987, Resh et al. 2008). Adult beetles crawl at a relatively slow pace.

Dryopid adults typically feed on biofilm (microorganisms and debris) scraped from surfaces such as rocks, wood, and vegetation (Brown 1987). Potential food sources may include detritus (decomposed materials), leaf litter, and decaying roots. However, it is possible that this species may feed on bacteria and fungi associated with decaying plant material (R. Gibson, Service, pers. comm. 2006). Some wild caught adult specimens have survived in captivity 11 to21-months (Barr and Spangler 1992, Fries et al. 2004), but lifespan is unknown.

Historic and Current Distribution

Comal Springs dryopid beetles were first collected in 1987 from the headwaters and outlets beneath either bank at Comal Springs Spring Run #2 (Barr and Spangler 1992). The species has subsequently been documented at Comal Spring Runs #1 through #5; in seeps along the western shoreline of Landa Lake; in upwellings within Landa Lake near Spring Island, and in Panther Canyon Well (about 360 feet from the head of Comal Spring Run 2) (BIO-WEST 2003-2009; Bowles, et al. 2003, Fries et al. 2004, Gibson et al. 2008, Gibson, pers. comm., 2012). The species has also been documented at Fern Bank Springs, located approximately 20 miles (32 km) northeast of Comal Springs in Hays County (Barr 1993, Gibson et al. 2008). The extent of the subterranean range of the species is unknown, though it has been suggested that they may be confined to small areas surrounding spring openings (Barr 1993, 62 FR 66295).

The Comal Springs dryopid beetle's specialized subterranean and aquatic adaptations indicate that the species evolved with and occupies subterranean areas within the aquifer. We believe, therefore, that the species relies primarily on these habitats, and only occasionally uses surface areas such as those near the spring openings. Based on the best available scientific and commercial information, we estimate a total surface population of Comal springs dryopid beetles in the Comal Springs system at1,839 individuals (Bowles and Stanford 2003, Gibson 2011).

Reasons for Decline and Threats to Survival

The listing rule describes reduction or loss of water of adequate quality and quantity as the main threat to the Comal Springs dryopid beetle, and States that this decline is due primarily to human activities including withdrawal of water from the San Antonio segment of the Edwards Aquifer (62 FR 66295). Comal Springs dryopid beetle larvae are found in moist soils and adults are restricted to aquatic environments by their reliance on a plastron for respiration. Loss of streamside soil moisture may therefore affect larvae, and the aquatic habitats occupied by adults are likely to be lost through drying or decreased spring flows during drought conditions.

The Comal Springs dryopid beetle is only known from two locations, and the non-swimming flightless aquatic beetle has limited opportunities to expand its range. The species is therefore presumed to have survived the DOR at Comal Springs and Fern Bank Springs, though because the species first collected in 1987 there are no records of species abundance and distribution before, during, or immediately after the DOR event, when Comal Springs stopped flowing for four-months.

Contamination from a variety of sources including, but not limited to, human waste (particularly from septic tanks), agricultural chemicals, urban runoff, and transportation of hydrocarbons and other potentially harmful materials throughout the Edwards Aquifer recharge zone and watershed have been identified as threats to water quality (62 FR 66295). The fine hydrophobic hairs on the abdomen of adults of the species can lose their capacity to trap the thin film of air through which these beetles respire when exposed to surfactants or solvents such as those found in soaps and detergents. Pollution such as groundwater contamination or as the result of a catastrophic event such as a hazardous material spill or other release within the watershed or into Landa Lake or its immediate tributaries constitutes another threat to the species. Landa Lake and its immediate tributaries are crossed by a total of five bridges, any of which could be the source of a spill that could affect the species or its designated critical habitat unit at Comal Springs. Stormwater inflows and other non-point sources of contamination may also pose a threat to the species.

This environmental baseline describes the current status of the species and is based upon impacts to which the species has been exposed (USFWS and NMFS 1998). To understand the potential effects of the currently authorized and actual pumping amounts as managed by the existing EAA CPM plan, springflow was modeled for a 53-year period (1947 through 2000) that included a range of precipitation conditions including the DOR event that occurred from 1949 to 1956.

When total maximum permitted pumping under current regulations is modeled, Comal Springs are projected to cease flowing for 38-months. For comparison purposes, San Marcos Springs are not recorded to have ever stopped flowing, even during the DOR. This projected model result, though useful in understanding potential effects of the existing aquifer management scheme, does not reflect impacts that the species have experienced because these conditions have not occurred since this management plan was adopted.

Modeling the same 53-year period using actual pumping totals rather than the maximum amount of pumping permitted provides a projection that may more accurately reflect current water use, including increased efficiency of agricultural operations and increased water conservation efforts throughout the region. Actual pumping from 2000 through 2010 averaged 381,000 acre feet (469,956,586 cubic meters) per year. Modeled Comal springflows using this recent average also projects that Comal Springs will cease flowing for-36 months during a repeat of DOR-like conditions (See HCP Table 4-30). This is a modeled result, and the species have not been impacted by the current pumping and management plans because the modeled drought conditions have not occurred since the current management plan was adopted. Figure 2 (above) illustrates the reported historic springflows and compares the effects of the baseline ("No

Action") and the HCP (Alternatives 2a and 2b) action at Comal Springs. Further description of this figure is available in Section 4.2 of the EIS.

The reduction and loss of springflows during severe drought conditions projected by these modeling efforts could have significant impacts to the Comal Springs dryopid beetle.

Survival Needs and Recovery Criteria

The chief survival need of the Comal Springs dryopid beetle identified in the listing rule is conservation of suitable habitat to sustain populations of the species. The conservation of Comal Springs dryopid beetle habitat includes maintenance of water quality and continuous natural springflow. No recovery plan has been finalized for the Comal Springs dryopid beetle, and no recovery criteria have been crafted for this species. A recovery team has been convened to address the needs of this species and a recovery plan that will include recovery criteria is currently being drafted.

Factors affecting the Species within the Action Area

The Comal Springs dryopid beetle has been the subject of five formal consultations for Federal actions unrelated to the action considered here. The USACE consulted with the Service for a bank stabilization and retaining wall replacement project, and for structural repairs to a Bridge over Comal Springs and to remove concrete footings from two bridges in Landa Lake. Two consultations concerned pumping of Edwards Aquifer water by the DOD on four military installations in Bexar County. The Service completed an intra-Service consultation regarding the pumping of Edwards Aquifer water that supports the continuing operations and refugia of the San Marcos National Fish Hatchery and Technology Center and the Uvalde National Fish Hatchery.

The incidental take of 93 Comal Springs dryopid beetles has been authorized under these consultations. None of these consultations resulted in a determination that the considered actions would jeopardize the Comal Springs dryopid beetle or result in destruction or adverse modification of designated critical habitat.

On April 27, 2012, the Texas Parks and Wildlife Commission amended the State List of Endangered Species (31 TAC §65.176) to include the Comal Springs dryopid beetle (Texas Register 2012). Section 68.002 of the TPW Code and Section 65.171 of the TAC prohibit take of endangered species, except under a State Scientific Research or Non-game Collection Permit. "Take" is defined in Section 1.101(5) of the TPW Code as collect, hook, hunt, net, shoot, or snare, by any means or device, and includes an attempt to take or to pursue in order to take. There are no provisions under the Texas Threatened and Endangered Species Regulations for reducing or eliminating the threats that may adversely affect the Comal Springs dryopid beetle or its habitat.

Critical Habitat

On July 17, 2007, the Center for Biological Diversity, Citizens Alliance for Smart Expansion, and Aquifer Guardians in Urban Areas provided the Service with a 60-day notice of intent to sue on the final critical habitat rules for a number of species, including the Comal Springs dryopid beetle. On January 14, 2009, the plaintiffs filed suit in U.S. District Court for the Western District of Texas on issues related to sections 3(5)(A) and 4(b)(2) of the Act. On December 18, 2009, the parties filed a settlement agreement in which the Service agreed to submit to the *Federal Register* a revised proposed rule for designation of critical habitat for these species on or before October 17, 2012 and a final rule for critical habitat on or before October 13, 2013.

At the time of this writing, a proposed rule has been published in the *Federal Register* in accordance with the settlement agreement, and public review and comment have been solicited. Because no change in designation has been established through rule-making, this analysis relies on the critical habitat designation currently in place. An analysis of the proposed revision of the designated critical habitat is found in the Conference Opinion section that follows.

Comal Springs dryopid beetle critical habitat was designated on July 17, 2007 in two units, referred to as the Comal Springs Unit and the Fern Bank Springs Unit (72 FR 39248). Both of these designated critical habitat units are within the action area considered in this consultation.

The Comal Springs Unit includes aquatic habitat within Landa Lake and outlying spring runs that occur from the confluence of Blieders Creek at the upstream end of Landa Lake to the lake's lowermost point of confluence with Spring Run No. 1; and land along the shoreline of Landa Lake and small islands within a 50-foot distance of spring outlets. Critical habitat in the Fern Bank Springs Unit includes aquatic habitat and land areas within a 50-foot distance from spring outlets, including the main outlet of Fern Bank Springs and its associated seep springs.

These designated critical habitat units include only aquatic and shoreline areas where primary constituent elements exist and do not include areas where these features do not occur, such as lawns, buildings, roads, parking lots, and sidewalks. Where lakes are included, critical habitat is only designated within a 50-foot radius around springs and does not include other areas of the lake bottom in areas where springs are absent.

Primary threats to designated critical habitat may vary for individual springs according to the degree of urbanization and availability of aquifer source water, but possible threats generally include prolonged cessation of spring flows as a result of the loss of hydrological connectivity within the aquifer (*e.g.*, groundwater pumping, excavation, concrete filling), pollutants (*e.g.*, stormwater drainage, pesticide use), and non-native species (*e.g.*, biological control, sport fish stocking). To address these threats management actions may be required. Examples of management actions include maintenance of sustainable groundwater use and subsurface flows, use of adequate buffers for water quality protection, selection of appropriate pesticides, and implementation of integrated pest management plans (72 FR 39248).

The primary constituent elements identified in the Critical Habitat designation for the Comal Springs dryopid beetle (72 FR 39248), are:

i. High-quality water with no or minimal levels of pollutants, such as soaps and detergents and other compounds containing surfactants, heavy metals, pesticides, fertilizer nutrients, petroleum hydrocarbons, pharmaceuticals and veterinary medicines, and semi-volatile compounds, such as industrial cleaning agents, and including:
   (a) Low salinity with total dissolved solids that generally range from 307 to 368 mg/L; and,
   (b) Low turbidity that generally is less than 5 nephelometric turbidity units;
ii. Aquifer water temperatures that range from approximately 68 to 75°F (20 to 23.9°C);
iii. A hydrologic regime that allows for adequate spring flows that provide levels of dissolved oxygen in the approximate range of 4.0 to 10.0 mg/L for respiration of the Comal Springs dryopid beetle; and,
iv. Food supply that includes detritus (decomposed materials), leaf litter, living plant material, algae, fungi, bacteria and other microorganisms, and decaying roots.

The Comal Springs designated critical habitat unit currently provides each of the primary constituents identified in the rulemaking. Water quality within Landa Lake and the identified spring runs remains free of contaminants, and salinities and turbidity have not been reported to exceed the identified requirements. Comal Springs temperatures reportedly remain nearly constant (annual reported mean 74.1°F [23.4°C]), and springflows continue to maintain dissolved oxygen levels supportive of the species. Food supplies as described in the critical habitat designation are present.

Fern Bank Springs and its associated critical habitat unit are both wholly located on private property, and researchers have had only limited and irregular access to this site. Information about the designated critical habitat and the ability of the crucial habitat unit to continue to provide primary constituent elements essential for the conservation of the species is therefore limited. The discharge at Fern Bank Springs has only been intermittently measured. Brune (1981) reported Fern Bank spring flow discharge of 4.9 cfs (0.14 cms) on May 31, 1975, and 0.3 cfs (0.008 cms) on May 1, 1978. A single-family owned the spring site from the late 1800s until 2009, and in 2008, the landowner claimed that the spring never ceased flowing during that time, including through the drought of the 1950s. There are, however, no data to either support or refute such claims.

f. Comal Springs riffle beetle

The entire range of the Comal Springs riffle beetle (*Heterelmis comalensis*) is within the action area, and this species description therefore constitutes the environmental baseline for this species.

Species Description and Life History

The Comal Springs riffle beetle is a small aquatic beetle first described in 1988 (Bosse et al. 1988). The species was listed as endangered on December 18, 1997 (62 FR 66295).

Larval Comal Springs riffle beetles are elongate, tubular in cross-section and light tan in color. The Comal Springs riffle beetle pupa is pale in color and legs and wing pads project loosely from the body. The number of larval instars among species in the family Elmidae ranges from 5 to 8 (Brown 1987), but the specific number of instars for Comal Springs riffle beetle is unknown. The incubation period of elmid eggs typically ranges from 5 to 15 days, and the larval Stages may last from 3 to 36-months (Brown 1987) before pupation occurs. Brown (1987) noted that mature elmid larvae pupate in protected areas above the water line.

Adult Comal Springs riffle beetles are reddish-brown in color, and range in length from 0.067 to 0.83 inches (1.7 to 21.0 mm). The sides of the body are approximately parallel and the entire dorsal surface is coated with fine golden-colored setae (hairs) (Bosse et al. 1988). The hind wings of Comal Springs riffle beetles are short and non-functional and the species is incapable of flying (Bosse et al. 1988).

Larval and adult populations at Comal Springs reach their greatest densities (about 0.5 per square foot [5 per square meter]) in late fall through winter, but all life stages can be found throughout the year suggesting multiple broods in a season with overlapping generations (Bowles et al. 2003). Completion of the life cycle in Comal Springs riffle beetles from egg, to larvae, to adult has been reported as requiring six-months to three-years (BIO-WEST 2006).

The Comal Springs riffle beetle is an epigean (surface-dwelling) species that inhabits fast flowing waters with gravel and cobble substrates (Bowles et al. 2003). Food sources include, but are not limited to, detritus, leaf litter, and decaying roots. Little is known of their life history and habitat (Bowles et al. 2003).

Recent research describes the species' strong associations with springs, and microhabitat preferences for spring outlet conditions and water quality parameters characteristic of Edwards Aquifer spring water. The Comal Springs riffle beetle exhibited preferences for temperatures near 73.4°F (23 °C), elevated CO_2, darkness, and low flow conditions (as might be expected for a species associated with gravel and cobble substrates) (Cooke 2012).

Historic and Current Distribution

The Comal Springs riffle beetle was first collected at Comal Springs in 1976 (Bosse et al. 1988). A single specimen was then collected at San Marcos Springs (Barr 1993). Comal Springs riffle beetles are now known from Comal Spring Runs #1, #2, and #3; at several spring outflows and seeps along the northwestern shore of Landa Lake; and near springs in Landa Lake and on Spring Island. Adults and larvae have been collected at San Marcos Springs from the springs along the escarpment near Aquarena Center and in locations in upper Spring Lake, indicating the presence of a reproducing population (Gibson et al. 2008). Efforts to verify the presence of the species from other springs in central Texas have failed to locate any individuals beyond those associated with Comal and San Marcos Springs. Based on the best available scientific and commercial information, we estimate a total surface population of 10,959 individuals in the Comal Springs system, but cannot estimate populations in the San Marcos system (Bowles et al 2003, Gibson 2011).

Reasons for Decline and Threats to Survival

The listing rule describes reduction or loss of water of adequate quality and quantity as the main threat to the Comal Springs riffle beetle, and States that this decline is due primarily to human activities including withdrawal of water from the San Antonio segment of the Edwards Aquifer (62 FR 66295). The limited amount of available habitat is likely to be impacted or lost through drying or decreased volume of spring flow during drought conditions.

The Comal Springs riffle beetle is only known from two locations, and the flightless aquatic beetle has limited opportunities to expand its range. The species is therefore presumed to have survived the DOR at Comal Springs and San Marcos Springs, though because the species was first collected in 1976 there are no records of species abundance and distribution before, during, or immediately after the DOR event.

Contamination from a variety of sources including, but not limited to, human waste (particularly from septic tanks), agricultural chemicals, urban runoff, and transportation of hydrocarbons and other potentially harmful materials throughout the Edwards Aquifer recharge zone and watershed were identified as threats to water quality. Pollution such as groundwater contamination or as the result of a catastrophic event such as a hazardous material spill or other release within the watershed or into Landa Lake, Spring Lake or their immediate tributaries constitutes another threat to the species. Landa Lake and its immediate tributaries are crossed by a total of five bridges, and Spring Lake and its immediate tributaries are crossed by a total of four bridges, any of which could be the source of a spill that could affect the species or its designated critical habitat units at Comal and San Marcos Springs. Stormwater inflows and other non-point sources of contamination may also pose a threat to the species.

Stagnation of water or drying within the occupied springs and spring runs may adversely affect the Comal Springs riffle beetle because flowing water with sufficient dissolved oxygen concentrations is considered important to respiration and therefore survival for this species.

Competition is not known to be a significant threat to this species, though the presence of non-native species (such as the snails *Marisa cornuarietis, Thiara granifera* and *Thiara tuberculata* present in the spring runs) that may compete directly or indirectly for food resources have been identified as an ongoing threat to the continued survival of the Comal Springs riffle beetle (62FR 66295).

This environmental baseline describes the current status of the species and is based upon impacts to which the species has been exposed (USFWS and NMFS 1998). To understand the potential effects of the currently authorized and actual pumping amounts as managed by the existing EAA CPM plan, springflow was modeled for a 53-year period (1947 through 2000) that included a range of precipitation conditions including the DOR event that occurred from 1949 to 1956.

When total maximum permitted pumping under current regulations is modeled, Comal Springs are projected to cease flowing for 38-months and San Marcos Springs are projected to stop flowing for 30 consecutive days. For comparison, during the 1949 to 1956 DOR, Comal Springs ceased flowing for four-months, and San Marcos Springs are not recorded to have ever stopped flowing. This projected model result, though useful in understanding potential effects of the existing aquifer management scheme, does not reflect impacts that the species have experienced because these conditions have not occurred since this management plan was adopted.

Modeling the same 53-year period using actual pumping totals rather than the maximum amount of pumping permitted provides a projection that may more accurately reflect current water use, including increased efficiency of agricultural operations and increased water conservation efforts throughout the region. Actual pumping from 2000 through 2010 averaged 381,000 acre feet (469,956,586 cubic meters) per year. Modeled Comal springflows using this recent average also projects that Comal Springs will cease flowing for 36-months, and San Marcos springflows stop flowing for 30 consecutive days during a repeat of DOR-like conditions (See HCP Table 4-30 and 4-31). This is a modeled result, and the species have not been impacted by the current pumping and management plans because the modeled drought conditions have not occurred since the current management plan was adopted. Figures 1 and 2 (above) illustrates the reported historic springflows and compares the effects of the baseline ("No Action") and the HCP (Alternatives 2a and 2b) action at San Marcos Springs and Comal Springs, respectively. Further description of these figures is available in Section 4.2 of the EIS.

The reduction and loss of springflows projected by these modeling efforts during severe drought conditions could have significant impacts to the Comal Springs riffle beetle.

Survival Needs and Recovery Criteria

The chief survival need of the Comal Springs riffle beetle identified in the listing rule is conservation of suitable habitat to sustain populations of the species. The conservation of Comal Springs riffle beetle habitat includes maintenance of water quality and continuous natural springflow at Comal and San Marcos springs. No recovery plan has been finalized for the Comal Springs riffle beetle at this time, though a recovery team has been convened and a recovery plan that will include recovery criteria is currently being drafted.

Factors affecting the Species within the Action Area

The Comal Springs riffle beetle has been the subject of seven formal consultations for Federal actions unrelated to the action considered here. The USACE consulted with the Service for a bank stabilization and retaining wall project, and bridge repairs and removal of concrete footings from two bridges at Landa Lake. Two consultations concerned pumping of Edwards Aquifer water by the DOD on four military installations in Bexar County. The Service completed an intra-Service consultation regarding the pumping of Edwards Aquifer water that supports the continuing operations and refugia of the San Marcos National Fish Hatchery and Technology Center and the Uvalde National Fish Hatchery.

The incidental take of 302 Comal Springs riffle beetles was authorized in conjunction with these consultations. None of these consultations resulted in a determination that the considered actions would jeopardize the Comal Springs riffle beetle or result in destruction or adverse modification of designated critical habitat.

On April 27, 2012, the Texas Parks and Wildlife Commission amended the State List of Endangered Species (31 TAC §65.176) to include the Comal Springs riffle beetle (Texas Register 2012). Section 68.002 of the TPW Code and Section 65.171 of the TAC prohibit take of endangered species, except under a State Scientific Research or Non-game Collection Permit. "Take" is defined in Section 1.101(5) of the TPW Code as to collect, hook, hunt, net, shoot, or snare, by any means or device, and includes an attempt to take or to pursue in order to take. There are no provisions under the Texas Threatened and Endangered Species Regulations for reducing or eliminating the threats that may adversely affect the Comal Springs riffle beetle or its habitat.

Critical Habitat

On July 17, 2007, the Center for Biological Diversity, Citizens Alliance for Smart Expansion, and Aquifer Guardians in Urban Areas provided the Service with a 60-day notice of intent to sue on the final critical habitat rules for a number of species, including the Comal Springs riffle beetle. On January 14, 2009, the plaintiffs filed suit in U.S. District Court for the Western District of Texas on issues related to sections 3(5)(A) and 4(b)(2) of the Act. On December 18, 2009, the parties filed a settlement agreement in which the Service agreed to submit to the Federal Register a revised proposed rule for designation of critical habitat for these species on or before October 17, 2012, and a final rule for critical habitat on or before October 13, 2013.

At the time of this writing, a proposed rule has been published in the Federal Register in accordance with the settlement agreement, and public review and comment have been solicited. Because no change in designation has been established through rule-making, this analysis relies on the critical habitat designation currently in place. An analysis of the proposed revision to the designated critical habitat is found in the Conference Opinion section that follows.

Critical habitat for the Comal Springs riffle beetle was designated on July 17, 2007 in two units, referred to as the Comal Springs Unit and the San Marcos Springs Unit (72 FR 39248). Both of these units are located within the action area for this consultation.

Designated critical habitat for the Comal Springs riffle beetle in the Comal Springs Unit includes aquatic habitat within Landa Lake and outlying spring runs that occur from the confluence of Blieders Creek at the upstream end of Landa Lake down to the lake's lowermost point of confluence with Spring Run # 1. The San Marcos Springs unit includes aquatic habitat areas within Spring Lake upstream of Spring Lake dam, with the exception of the slough portion of the lake upstream of its confluence with the main body.

Primary threats to designated critical habitat may vary for individual springs according to the degree of urbanization and availability of aquifer source water, but possible threats generally include prolonged cessation of spring flows as a result of the loss of hydrological connectivity within the aquifer (e.g., groundwater pumping, excavation, concrete filling), pollutants (e.g., stormwater drainage, pesticide use), and non-native species (e.g., biological control, sport fish stocking). To address these threats management actions may be required—for example, maintenance of sustainable groundwater use and subsurface flows, use of adequate buffers for water quality protection, selection of appropriate pesticides, and implementation of integrated pest management plans.

The primary constituent elements identified in the critical habitat designation for the Comal Springs dryopid beetle (72 FR 39248), are:

i. High-quality water with no or minimal levels of pollutants, such as soaps and detergents and other compounds containing surfactants, heavy metals, pesticides, nutrients, petroleum hydrocarbons, pharmaceuticals and veterinary medicines, and semi-volatile compounds, such as industrial cleaning agents, and including:
   (a) Low salinity with total dissolved solids that generally range from 307 to 368 mg/L; and,
   (b) Low turbidity of generally less than 5 nephelometric turbidity units;

ii. Aquifer water temperatures that range from approximately 68 to 75 °F (20 to 23.9°C);

iii. A hydrologic regime that allows for adequate spring flows that provide levels of dissolved oxygen in the approximate range of 4.0 to 10.0 mg/L;

iv. Food supply that includes detritus (decomposed materials), leaf litter, living plant material, algae, fungi, bacteria and other microorganisms, and decaying roots; and,

v. Bottom substrate in surface water habitat that is free of sand and silt, and is composed of gravel and cobble ranging in size between 0.3 to 5.0 inches (0.76 to 12.7 cm).

Both the Comal Springs and San Marcos Springs designated critical habitat units currently provide the primary constituent elements identified as essential for the conservation of the species. Water quality at both sites remains free from contamination and salinity and turbidity are within the described parameters. Water temperature averages approximately 74°F (23.3°C) in the Comal Springs system, and 70°F (21.1°C) at San Marcos Springs. Springflows continue to maintain dissolved oxygen levels at both locations, and food supplies are present. Bottom substrates in the designated critical habitat unit in the Comal system remain largely free of sand and silt. Substrates in Spring Lake have been impacted by sediments to a greater degree.

g. Texas cave diving beetle

The entire range of the Texas cave diving beetle (*Haideoporus texanus*, sometimes referred to as the Edwards Aquifer diving beetle) is within the action area, and this species description therefore constitutes the environmental baseline for this species.

Species Description and Life History

The Texas cave diving beetle was the first described North American cave-adapted beetle in the family Dytiscidae (Young and Longley 1976). Adults of the species are small (0.13 to 0.15 inches [3.4 to 3.7mm]), elongate, and somewhat flattened. They have reduced and apparently non-functional eyes, and lack pigment and hind wings (Young and Longley 1976). Larvae are described as 0.2 inches (5.5 mm) in length and 0.07 inches (1.8 mm) in greatest width, with transparent and light yellow-brown tinted bodies (Longley and Spangler 1977). Specific habitat requirements are unknown (TPWD 1995).

Historic and Current Distribution

The Texas cave diving beetle was first collected from an artesian well located on the campus of Texas State University in San Marcos (Bowles and Stanford 1997), which is the same well as the type locality for the Texas blind salamander (Young and Longley 1976). The species has subsequently been collected from spring orifices at Comal Springs (Bowles and Stanford 1997). This species is believed to be restricted to the subterranean waters of the Edwards Aquifer in Hays and Comal Counties (TPWD 1995).

Reasons for Decline and Threats to Survival

Groundwater pumping has been described as a major threat to this species' habitat (TPWD 1995). It has been suggested that the species may be sensitive to deterioration of water quality (TPWD 1995).

This environmental baseline describes the current status of the species and is based upon impacts to which the species has been exposed (USFWS and NMFS 1998). To understand the potential effects of the currently authorized and actual pumping amounts as managed by the existing EAA CPM plan, springflow was modeled for a 53-year period (1947 through 2000) that included a range of precipitation conditions including the DOR event that occurred from 1949 to 1956.

When total maximum permitted pumping under current regulations is modeled, Comal Springs are projected to cease flowing for 38-months and San Marcos Springs are projected to stop flowing for 30 consecutive days. For comparison, during the 1949 to 1956 DOR, Comal Springs ceased flowing for four-months, and San Marcos Springs are not recorded to have ever stopped flowing. This projected model result, though useful in understanding potential effects of the existing aquifer management scheme, does not reflect impacts that the species have experienced because these conditions have not occurred since this management plan was adopted.

Modeling the same 53-year period using actual pumping totals rather than the maximum amount of pumping permitted provides a projection that may more accurately reflect current water use, including increased efficiency of agricultural operations and increased water conservation efforts throughout the region. Actual pumping from 2000 through 2010 averaged 381,000 acre feet (469,956,586 cubic meters) per year. Modeled Comal springflows using this recent average also projects that Comal Springs will cease flowing for 36-months, and San Marcos springflows stop flowing for 30 consecutive days during a repeat of DOR-like conditions (See HCP Table 4-30 and 4-31). This is a modeled result, and the species have not been impacted by the current pumping and management plans because the modeled drought conditions have not occurred since the current management plan was adopted. Figures 1 and 2 (above) illustrates the reported historic springflows and compares the effects of the baseline ("No Action") and the HCP (Alternatives 2a and 2b) action at San Marcos Springs and Comal Springs, respectively. Further description of these illustrations is available in Section 4.2 of the EIS.

Springflows are a function of aquifer level, and the reduction and loss of springflows projected by these modeling efforts during severe drought conditions suggests lowered aquifer levels.

Given the species apparent restriction to the waters of the aquifer in the Comal and Hays Counties, these lowered aquifer levels may represent impacts to the Texas cave dining beetle and its habitat.

Survival Needs and Recovery Criteria

Though little is yet known about the specific survival needs for this species, the Texas cave diving beetle's adaptations to subterranean aquatic conditions suggest that adequate supplies of water of suitable quality are required. Because this species has not been listed, no recovery criteria have been established.

Factors affecting the Species within the Action Area

No consultations that consider potential impacts to this species have previously been completed.

Critical Habitat

The Texas cave diving beetle is not currently listed as threatened or endangered, and therefore no critical habitat has been designated for this species.

h. **Texas troglobitic water slater**

The entire range of the Texas troglobitic water slater (*Lirceolus smithii*) is within the action area, and this species description therefore constitutes the environmental baseline for this species.

Species Description and Life History

The Texas troglobitic water slater was the first subterranean freshwater isopod in the family Asellidae discovered in the western U. S. (Lewis 2001). The species was first collected in 1899 from the artesian well drilled by the U. S. Fish Commission that had also provided the Texas blind salamander type specimen. The species was described from the originally collected single but incomplete specimen as *Caecidotea smithii* (Ulrich 1902). This description was later revisited and revised as *Lirceolus smithii* based upon new collections of the species from the same location that revealed previously undescribed but distinctive features (Bowman and Longley 1976).

The Texas troglobitic water slater is a small (approximately 0.15 inches [3.7 mm] in length), blind, and unpigmented isopod (Bowman and Longley 1976). Diagnostic characteristics such as the structure and the number and position of spines on the maxilla, and the unusually small size of pleopods 4 and 5 (Bowman and Longley 1976) are not easily observed in the field, and microscopic examination is required to confirm identification.

Little is known about Texas troglobitic water slater reproduction, life span, or habitat requirements in the wild.

Historic and Current Distribution

Originally collected from the artesian well drilled by the U. S. Fish Commission (now on the campus of Texas State University) in 1899 (Bowman and Longley 1976), the species has subsequently been confirmed in drift samples collected at San Marcos Springs (Gibson et al. 2008).

Reasons for Decline and Threats to Survival

The Service cited the present or threatened destruction, modification, or curtailment of habitat or range resulting from aquifer drawdown and decreasing water quality as potential threats to the species in a 90-day finding on a petition to list the species, as threatened or endangered (74FR 66866). In this finding, the Service determined that the information provided in the petition or otherwise readily available indicated that listing as threatened or endangered may be warranted.

This environmental baseline describes the current status of the species and is based upon impacts to which the species has been exposed (USFWS and NMFS 1998). To understand the potential effects of the currently authorized and actual pumping amounts as managed by the existing EAA CPM plan, springflow was modeled for a 53-year period (1947 through 2000) that included a range of precipitation conditions including the DOR event that occurred from 1949 to 1956.

When total maximum permitted pumping under current regulations is modeled, San Marcos Springs are projected to stop flowing for 30 consecutive days. For comparison, San Marcos Springs are not recorded to have ever stopped flowing. This projected model result, though useful in understanding potential effects of the existing aquifer management scheme, does not reflect impacts that the species have experienced because these conditions have not occurred since this management plan was adopted.

Modeling the same 53-year period using actual pumping totals rather than the maximum amount of pumping permitted provides a projection that may more accurately reflect current water use, including increased efficiency of agricultural operations and increased water conservation efforts throughout the region. Actual pumping from 2000 through 2010 averaged 381,000 acre feet (469,956,586 cubic meters) per year. Modeled San Marcos springflows using the recent average pumping totals are projected to stop flowing for 30 consecutive days during a repeat of DOR-like conditions (See HCP Table 4-30 and 4-31). This is a modeled result, and the species have not been impacted by the current pumping and management plans because the modeled drought conditions have not occurred since the current management plan was adopted. Figure 1 (above) illustrates the reported historic springflows and compares the effects of the baseline ("No Action") and the HCP (Alternatives 2a and 2b) action at San Marcos Springs. Further description of this figure is available in Section 4.2 of the EIS.

The reduction and loss of springflows projected by these modeling efforts during severe drought conditions may represent impacts to the Texas troglobitic water slater and its habitat.

Pollution such as groundwater contamination or as the result of a catastrophic event such as a hazardous material spill or other release within the watershed or into Spring Lake or its immediate tributaries constitutes another threat to the species. Spring Lake and its immediate tributaries are crossed by a total of four bridges, any of which could be the source of a spill that could affect the species. Stormwater inflows and other non-point sources of contamination may also pose a threat to the species.

Survival Needs and Recovery Criteria

Though little is yet known about the specific survival needs for this species, the species adaptations to aquatic subterranean conditions suggest that adequate supplies of water of suitable quality are required. This species is not currently listed, and therefore no recovery criteria have been established.

Factors affecting the Species within the Action Area

No consultations that consider potential impacts to this species have previously been completed.

Critical Habitat

The Edwards Aquifer diving beetle is not currently listed as threatened or endangered, and therefore no critical habitat has been designated for this species.

i. Peck's cave amphipod

The entire range of the Peck's cave amphipod (*Stygobromus pecki*) is within the action area, and this species description constitutes the environmental baseline for this species.

Species Description and Life History

Peck's cave amphipod is a subterranean-adapted aquatic crustacean first collected in 1964 at Comal Springs. The species is eyeless and unpigmented, and is distinguished from the similar *S. dejectus* by its proportionally longer 1st antennae, larger and more numerous teeth on the gnathopods (claws), and larger size (about 0.41 inches [10.5 mm]) (Holsinger 1967). Verification of this species is usually not possible in the field, as microscopic examination of adult specimens is usually required. Peck's cave amphipod was listed as endangered on December 18, 1997 (62 FR 66295).

Some evidence suggests Peck's cave amphipod is omnivorous, and can feed as a predator, scavenger or detritivore (USFWS 2007). Food sources may include living materials, detritus, leaf litter, and decaying roots. The species may also feed on bacteria and fungi associated with decaying plant material.

Peck's cave amphipod inhabits the subterranean spaces associated with springs issuing from the Edwards Aquifer. The species has been reported from gravel, rocks, and organic debris (leaves, roots, wood) immediately inside of or adjacent to springs, seeps and upwellings of Comal Springs and Landa Lake (Gibson et al. 2008). Collections of the species from Panther Canyon well support early characterizations of the species as being associated with deep groundwater habitats (Holsinger 1967).

Little is known about Peck's cave amphipod reproduction and life span in the wild. Mature and immature life Stages have been collected near spring outlets, from seeps along the spring runs, and from Panther Canyon Well (Gibson et al. 2008). Limited and intermittent reproduction has occurred with captive stock in aquaria at the San Marcos Aquatic Resource Center (formerly known as the San Marcos National Fish Hatchery and Technology Center). Other troglobitic species of amphipods are known to live for as many as 5 to 6-years in stable habitats with relatively continuous inputs of food materials (Culver 1982).

A recent analysis of known Peck's cave amphipod populations examined genetic variation to assess population structure within the species (Nice and Ethridge 2011). This study estimated the degree to which the sampling localities of this species were differentiated or isolated from each other. Nice and Ethridge (2011) found that genetic sequences showed high levels of differentiation within and among Peck's cave amphipod localities. They also found sequences from two distinct haplotypes (a genetic segment or group of genes inherited from a single parent) with deep divergence (Nice and Ethridge 2011). The two haplotypes were not geographically separated and often co-occurred in similar proportions. This observation suggests that what appears to be a single species of Peck's cave amphipod might instead be two similar-looking species living together that do not interbreed.

Another explanation could be that a common ancestor separated some time ago causing divergence that resulted in two core subterranean populations isolated by hydrogeology. Then over time, these populations reconnected at Comal Springs via a downstream dispersal mechanism while dispersal upstream into the aquifer (mixing of core populations) might be hindered. For example, predation and competition with the established community and hydrogeological features such as underground waterfalls, tight interstitial spaces, and high flow conduits might allow immature individuals to pass downstream but block upstream dispersal (Gibson 2012a, pers. comm.).

Despite this new information, a formal, peer-reviewed description of the two possible species has not been published. Therefore, we do not recognize a separation of the Peck's cave amphipod into two species because this split has not been recognized by the scientific community.

Historic and Current Distribution

Peck's cave amphipod has been collected from Comal Springs, Hueco Springs, and in Panther Canyon well, which is about 360 feet from Spring Run # 2 (Comal Springs) (Holsinger 1967, Arsuffi 1993, Barr 1993, Gibson et al. 2008). Panther Canyon well is not currently pumped and consists of a cased borehole approximately 6 inches in diameter situated inside of a small well house. Dye tracing efforts have demonstrated connectivity between Panther Canyon Well and Comal Spring Run # 3 (LBG-Guyton and Associates 2004).

Researchers examining amphipod assemblages from springs, caves, and wells in Comal, and neighboring Hays and Bexar counties have yet to confirm the presence of the species from any other locations (Holsinger 1967, 1978; Holsinger and Longley 1980; Barr 1993; Gibson et al. 2008). This suggests that Peck's cave amphipod may be confined to groundwater conduits in the vicinity of spring openings as opposed to generally inhabiting the aquifer at large.

The Peck's cave amphipod's specialized subterranean and aquatic adaptations indicate that the species evolved with and occupies subterranean areas within the aquifer. We believe, therefore, that the species relies primarily on these habitats, and only occasionally uses surface areas such as those near the spring openings. Based on the best available scientific and commercial information, we estimate a total surface population of at 21,700 based on sampling and collection data (Bowles and Stanford 2003, Gibson et al 2008). There are few estimates of populations at Hueco Springs, though the persistence of the species at this location which reportedly ceases to flow during drought conditions supports the hypothesis that the species relies primarily on the subterranean aquatic habitats rather than the surface springs of the Edwards Aquifer.

Reasons for Decline and Threats to Survival

The listing rule describes reduction or loss of water of adequate quality and quantity as the main threat to the Peck's cave amphipod, and States that this decline is due primarily to human activities including withdrawal of water from the San Antonio segment of the Edwards Aquifer (62 FR 66295).

Contamination from a variety of sources including, but not limited to, human waste (particularly from septic tanks), agricultural chemicals, urban runoff, and transportation of hydrocarbons and other potentially harmful materials throughout the Edwards Aquifer recharge zone and watershed are considered threats to water quality. Pollution such as groundwater contamination or as the result of a catastrophic event such as a hazardous material spill or other release within the watershed or into Landa Lake or its immediate tributaries constitutes another threat to the species. Landa Lake and its immediate tributaries are crossed by a total of five bridges, any of which could be the source of a spill that could affect the species or its designated critical habitat unit at Comal Springs.

To estimate the effect of the currently authorized annual pumping and CPM plan, springflow at Comal Springs was modeled for a 53-year period (1947 through 2000) that included a range of precipitation conditions including the DOR event that occurred from 1949 to 1956.

When total maximum permitted pumping in accordance with the current CPM plan is modeled, Comal Springs are projected to cease flowing for 38-months. This projected model result, though useful in understanding potential effects of the existing aquifer management scheme, does not reflect impacts that Peck's cave amphipod has experienced because these conditions have not occurred since this management plan was adopted. Figure 2 (above) illustrates the reported historic springflows and compares the effects of the baseline ("No Action") and the HCP (Alternatives 2a and 2b) action at Comal Springs. Further description of these figures is available in Section 4.2 of the EIS.

The environmental baseline describing the current status of the species is based upon impacts to which the species has been exposed (USFWS and NMFS 1998). Modeling the same conditions using actual pumping totals rather than the maximum total pumping permitted provides a projection that more closely meets the definition of environmental baseline. Actual pumping from 2000 through 2010 averaged 381,000 acre feet (469,956,586 cubic meters) per year. Modeled Comal springflows using this recent average also projects that Comal Springs will cease flowing for 36-months during a repeat of DOR-like conditions. During the 1949 to 1956 DOR, Comal Springs ceased flowing for four-months (See HCP Table 4-30).

Survival Needs and Recovery Criteria

The chief survival need identified in the Peck's cave amphipod listing rule is conservation of suitable habitat to sustain populations of the species. The conservation of Peck's cave amphipod habitat includes maintenance of water quality and continuous natural springflow. No Recovery Plan has been finalized for the Comal Springs dryopid beetle at this time, though a Recovery Team has been convened and a Recovery Plan that will include Recovery Criteria is currently being drafted.

Factors affecting the Species within the Action Area

Peck's cave amphipod has been the subject of five formal consultations for Federal actions unrelated to the action considered here. The USACE consulted with the Service for a bank stabilization and retaining wall replacement project, and for structural repairs to a Bridge over Comal Springs and to remove concrete footings from two bridges in Landa Lake. Two consultations concerned pumping of Edwards Aquifer water by the DOD on four military installations in Bexar County. The Service completed an intra-Service consultation regarding the pumping of Edwards Aquifer water that supports the continuing operations and refugia of the San Marcos National Fish Hatchery and Technology Center and the Uvalde National Fish Hatchery.

The incidental take of 683 Peck's cave amphipods has been authorized under these consultations. None of these consultations resulted in a determination that the considered actions would jeopardize the Comal Springs dryopid beetle or result in destruction or adverse modification of designated critical habitat.

On January 8, 2010, the Texas Parks and Wildlife Commission placed Peck's cave amphipod on the State list of endangered species (Texas Register 2010). Section 68.002 of the TPW Code and Section 65.171 of the TAC prohibit take of a threatened species, except under a State Scientific Research or Non-game Collection Permit. "Take" is defined in Section 1.101(5) of the TPW Code as to collect, hook, hunt, net, shoot, or snare, by any means or device, and includes an attempt to take or to pursue in order to take. There are no provisions under the Texas Threatened and Endangered Species Regulations for reducing or eliminating the threats that may adversely affect Peck's cave amphipod or its habitat.

Critical Habitat

On July 17, 2007, the Center for Biological Diversity, Citizens Alliance for Smart Expansion, and Aquifer Guardians in Urban Areas provided the Service with a 60-day notice of intent to sue on the final critical habitat rules for a number of species, including Peck's cave amphipod. On January 14, 2009, the plaintiffs filed suit in U.S. District Court for the Western District of Texas on issues related to sections 3(5)(A) and 4(b)(2) of the Act. On December 18, 2009, the parties filed a settlement agreement in which the Service agreed to submit to the Federal Register: (1) a revised proposed rule for designation of critical habitat for these species on or before October 17, 2012 and (2) a final rule for critical habitat on or before October 13, 2013.

At the time of this writing, a proposed rule has been published in the Federal Register in accordance with the settlement agreement, and public review and comment have been solicited. An analysis of the effects of the action on the currently proposed changes to the designated critical habitat for Peck's cave amphipod is provided in the Conference Opinion Conclusion section that follows. Because no change in designation has yet been established through rule-making, this analysis considers the critical habitat designation currently in place.

Critical habitat for Peck's cave amphipod was designated on 17 July 2007 in two locations referred to as the Comal Springs and Hueco Springs Units (72 FR 39248), both of which are wholly within the action area described for this consultation.

Designated critical habitat for the Peck's cave amphipod in the Comal Springs Unit is described as aquatic habitat within Landa Lake and outlying spring runs that occur from the confluence of Blieders Creek at the upstream end of Landa Lake down to the lake's lowermost point of confluence with Spring Run # 1; and land along the shoreline of Landa Lake and islands within a 50-ft (15.2-m) distance from spring outlets. Critical habitat does not include other areas of the lake bottom in areas where springs are absent (72 FR 39248).

In the Hueco Springs Unit, critical habitat was designated as the aquatic habitat and land areas within 50-feet (15.2 m) from habitat spring outlets, including the main outlet of Hueco Springs and its associated satellite springs. The critical habitat designated for the Peck's cave amphipod includes only aquatic habitat and land areas where PCEs exist for this species. Areas consisting of buildings, roads, sidewalks, campgrounds, and lawns are excluded (72 FR 39248).

Primary threats to designated critical habitat may vary for individual springs according to the degree of urbanization and availability of aquifer source water, but possible threats generally include prolonged cessation of spring flows as a result of the loss of hydrological connectivity within the aquifer (e.g., groundwater pumping, excavation, concrete filling), pollutants (e.g., stormwater drainage, pesticide use), and non-native species (e.g., biological control, sport fish stocking). To address these threats management actions may be required—for example, maintenance of sustainable groundwater use and subsurface flows, use of adequate buffers for water quality protection, selection of appropriate pesticides, and implementation of integrated pest management plans (72 FR 39248).

The primary constituent elements identified in the Critical Habitat designation for the Peck's cave amphipod include (72 FR 39248):

i. High-quality water with no or minimal levels of pollutants, such as soaps and detergents and other compounds containing surfactants, heavy metals, pesticides, fertilizer nutrients, petroleum hydrocarbons, pharmaceuticals and veterinary medicines, and semi-volatile compounds, such as industrial cleaning agents, and including:
    (a) Low salinity with total dissolved solids that generally range from 307 to 368 mg/L; and

(b) Low turbidity that generally is less than 5 nephelometric turbidity units;

ii. Aquifer water temperatures that range from approximately 68 to 75 °F (20 to 24 °C); and,

iii. Food supply that includes detritus (decomposed materials), leaf litter, living plant material, algae, fungi, bacteria and other microorganisms, and decaying roots.

The Comal Springs designated critical habitat unit currently provides each of the primary constituents identified in the rulemaking. Water quality within Landa Lake and the identified spring runs remains free of contaminants, and salinities and turbidity have not been reported to exceed the identified requirements. Comal Springs temperatures reportedly remain nearly constant (annual reported mean 74.1°F [23.4°C]), and food supplies described in the critical habitat designation are present.

Hueco Springs and its associated critical habitat unit consists of a large spring on the west side of that has reportedly stops flowing during severe drought events (Ogden et al. 1986b), and an intermittent spring on the east side of River Road that typically stops flowing during the driest months each year (Puente 1976, Barr 1993, Guyton and Associates 1979). These springs are both located on private property, and researchers have had only limited and irregular access to this site. Information about the designated critical habitat and the ability of the crucial habitat unit to continue to provide primary constituent elements essential for the conservation of the species is therefore limited.

j. Fountain darter

The entire ranged of the fountain darter (*Etheostoma fonticola*) is within the action area, and this species description therefore constitutes the environmental baseline for this species.

Species Description and Life History

The fountain darter was listed under the Endangered Species Conservation Act of 1969 on October 13, 1970 (35 FR 16047). The species was subsequently incorporated into the list of species threatened with extinction on October 13, 1970 (35 FR 16047) after the passage of the Endangered Species Conservation Act of 1969, and was again confirmed as an endangered species on September 26, 1975 after the Endangered Species Act of 1973 superseded the earlier endangered species statues (40 FR 44412).

The fountain darter is a small (usually less than 1 inch), benthic, reddish-brown fish (Page and Burr 1979). Three small dark spots are present on the base of the tail and there is a dark spot on the opercle (a boney flap covering the gills) (Jordan and Gilbert 1886; Gilbert 1887; Jordan and Evermann 1896).

Fountain darters spawn year-round (Schenck and Whiteside 1977b). Some authors have described two peak spawning periods, one in August and another late winter to early spring (Schenck and Whiteside 1977b), while others have suggested that fountain darter reproduction may be tied to habitat quality (BIO-WEST 2007b). Some data supports year-round reproduction in areas of high-quality habitat in both the Comal and San Marcos systems (e.g., Spring Lake, Landa Lake), with a strong spring peak in reproduction (with limited reproduction in summer and fall of most years) in areas of lower quality habitat farther downstream (BIO-WEST 2007b).

Fountain darter eggs have been found attached to bryophytes and algae in Spring Lake and on filamentous algae *Rhizoclonium* sp., *Ludwigia repens*, *Sagittaria* sp., and the endangered Texas wild-rice in the San Marcos River (Dowden 1968, Phillips and Alexander unpublished data). After hatching, fry are not free swimming, in part due to the reduced size of their swim bladders.

Fountain darters prefer undisturbed stream floor habitats; a mix of submergent plants (algae, mosses, and vascular plants), in part for cover; clear and clean water; an invertebrate food supply of living organisms (copepods, dipteran (fly) larvae, and mayfly larvae); constant water temperatures within the natural and normal river gradients; and adequate springflows (Bergin 1996, Schenck and Whiteside 1977a). Fountain darters are rarely found in areas lacking vegetation (BIO-WEST 2007b), and in habitat studies within the San Marcos River, Schenck and Whiteside (1976) never found fountain darters in areas without vegetation.

Historic and Current Distribution

The fountain darter was historically found in the San Marcos and Comal rivers (Service 1996). The type specimens were collected from the San Marcos River immediately below the confluence with the Blanco River in 1884 (Jordan and Gilbert 1886). The first records from the Comal River consisted of 43 specimens collected in 1891 (Evermann and Kendall 1894).

The fountain darter is known to have been present in the San Marcos River from the headwaters (including Spring Lake) downstream to the vicinity of Martindale in Caldwell County (Service 1996). Fountain darters can currently be found Spring Lake to a point between the San Marcos Waste Water Treatment Plant (WWTP) outfall and the confluence with the Blanco River (Service 1996). Researchers have estimated the San Marcos River population of the fountain darter to total 45,900 individuals (downstream of and excluding Spring Lake) (Linam 1993), to as many as 103,000 (Schenck and Whiteside 1976). Fountain darter densities appear to be highest in the upper segments of the San Marcos River and decrease markedly in an area below Cape's Dam (Linam 1993, Whiteside et al. 1994).

The fountain darter population was extirpated from the Comal River system in the mid-1950's (Schenk and Whiteside 1976). In 1954, rotenone was applied to the Comal system to remove non-native and exotic fish, and fountain darter populations may have been adversely impacted to an unknown degree by this effort (Ball et al. 1952; Service 1996). The primary cause of extirpation, however, is thought to be the 1949-1956 DOR.

Researchers proposed that the most likely cause was the cessation of Comal Springs flows for 144 days from June to November, 1956 (Schenck and Whiteside 1976). This event likely resulted in significant temperature fluctuations in remaining pools of water, decreased habitat and water quality, and increased predation of fountain darters.

Intensive surveys from 1973 to 1975 were unable to verify presence of the species in the Comal River system. From February 1975 through March 1976 about 450 fountain darters collected from the San Marcos River were released into the headsprings of the Comal River and into the old Comal River channel. By June of 1976 five offspring were found a short distance below the headsprings, confirming recruitment and reestablishment of a population (Schenck and Whiteside 1976). Fountain darters now occupy Comal Springs and the Comal River from Landa Lake downstream approximately three miles to the confluence with the Guadalupe River. A 1990 survey estimated that the Comal River population totaled about 168,078 individuals between the headwater springs and Clemens Dam (Linam et al. 1993).

Current extrapolated population estimates place fountain darter populations at approximately 774,000 individuals within the Comal River system (including Landa Lake), 480,000 individuals within the San Marcos River, and 455,400 individuals within the high quality habitat within Spring Lake (approximately 414,000 square feet with estimated fountain darter densities of 1.1 darter per square foot [11.8 darters per square meter]) (Bio-West 2011a, 2011b).

Reasons for Decline and Threats to Survival

The San Marcos and Comal Springs and Associated Aquatic Ecosystems Recovery Plan identifies several threats to the fountain darter (Service 1996a). The primary threats are related to the quantity and quality of aquifer and spring water. Drought conditions, groundwater use, and lower than average springflows threaten the species recovery. Activities that may pollute the Edwards aquifer and its springs and streamflows may also threaten the species. Additional threats include effects from increased urbanization near the rivers; recreational activities; habitat modification; predation, competition, and habitat alteration by non-native species; and the effects of introduced parasites (Service 1996a).

Fountain darters require high quality Edwards Aquifer water. Groundwater contamination or pollution resulting from a catastrophic event such as a hazardous material spill into the Comal or San Marcos Rivers constitutes another threat to the species. The Comal River and Landa Lake and their immediate tributaries are crossed by a total of 19 bridges including three railroad bridges; and the upper San Marcos River including Spring Lake and their immediate tributaries are crossed by a total of 30 bridges including four railroad bridges and six associated with Interstate Highway 35. Any of these river crossings could be the source of a spill or release that could affect the species or its designated critical habitat in the San Marcos River. Stormwater inflows and other non-point sources of contamination may also pose a threat to the species. Recreational use of the San Marcos River can also result in adverse impacts to fountain darters. Recreation in the San Marcos River has been reported as seasonal, with the highest use during summer months, holidays and weekends (Bradsby1994). Recreational uses that physically alter habitats or that result in loss of aquatic vegetation, such as trampling or uprooting vegetation, may affect the fountain darter's ability to feed and shelter. Fountain darters reproduce by adhering eggs to aquatic plants (Dowden 1968, Phillips and Alexander unpublished data). Impacts to vegetation that supports fountain darter eggs could affect breeding success.

Non-native species can threaten fountain darters though competition, habitat disturbance, and parasitic infection. Introduced fishes found in these river systems include tilapia (*Cichlidae*) that disrupt substrates thereby increasing turbidity and alter habitats by clearing areas of aquatic vegetation, thereby potentially affecting fountain darter sheltering and breeding habitats. Suckermouth catfishes (*Loricaridae*) disrupt substrates and may burrow into and destabilize riverbanks, thereby introducing additional sediment loads and turbidity into the river systems.

Another non-native species that threatens the fountain darter is a parasitic trematode that attacks the fish's gills (Mitchell et al. 2000 and McDonald et al. 2006). The trematode is native to Southeast Asia, and is associated with the presence of a non-native snail in the Comal and San Marcos systems. The adverse effects of these parasites on their fountain darter hosts is believed to increase during stressful conditions associated with low flow rates (Cantu 2003), and the parasite's adverse effects may have greater effects on younger fountain darter life-Stages (McDonald et al. 2006). Currently, the trematode is more prevalent in the Comal system. In the San Marcos system the parasite is somewhat localized to river reaches near IH-35. A concern is the potential spread of the trematode throughout this system (through movement of various fish, snails, and avian intermediate hosts) thus adversely affecting the entire San Marcos fountain darter population.

This environmental baseline describes the current status of the species and is based upon impacts to which the species has been exposed (USFWS and NMFS 1998). To understand the potential effects of the currently authorized and actual pumping amounts as managed by the existing EAA CPM plan, springflow was modeled for a 53-year period (1947 through 2000) that included a range of precipitation conditions including the DOR event that occurred from 1949 to 1956.

When total maximum permitted pumping under current regulations is modeled, Comal Springs are projected to cease flowing for 38-months and San Marcos Springs are projected to stop flowing for 30 consecutive days. For comparison, during the 1949 to 1956 DOR, Comal Springs ceased flowing for four-months, and San Marcos Springs are not recorded to have ever stopped flowing. This projected model result, though useful in understanding potential effects of the existing aquifer management scheme, does not reflect impacts that the species have experienced because these conditions have not occurred since this management plan was adopted.

Modeling the same 53-year period using actual pumping totals rather than the maximum amount of pumping permitted provides a projection that may more accurately reflect current water use, including increased efficiency of agricultural operations and increased water conservation efforts throughout the region. Actual pumping from 2000 through 2010 averaged 381,000 acre feet (469,956,586 cubic meters) per year. Modeled Comal springflows using this recent average also projects that Comal Springs will cease flowing for 36-months, and San Marcos springflows stop flowing for 30 consecutive days during a repeat of DOR-like conditions (See HCP Table 4-30 and 4-31). This is a modeled result, and the species have not been impacted by the current pumping and management plans because the modeled drought conditions have not occurred since the current management plan was adopted. Figures 1 and 2 (above) illustrate the reported historic springflows and compare the effects of the baseline ("No Action") and the HCP (Alternatives 2a and 2b) action at San Marcos Springs and Comal Springs, respectively. Further description of these figures is available in Section 4.2 of the EIS.

The reduction and loss of springflows projected by these modeling efforts during severe drought conditions could have significant impacts to the fountain darter in both the Comal and San Marcos River systems.

Survival Needs and Recovery Criteria

The San Marcos and Comal Springs and Associated Aquatic Ecosystems Recovery Plan (Service 1996a) that includes fountain darter, identifies specific recovery actions including ensuring adequate flows and water quality in the San Marcos River; maintenance of genetically diverse reproductive populations in captivity and creation of reintroduction techniques for use in the event of a catastrophic event; removal or reduction of threats due to non-native species, recreational use of the river, and habitat alteration; and maintenance of healthy, self-sustaining, reproductive populations in the wild.

Factors affecting the Species within the Action Area

The fountain darter has been the subject of 12 formal consultations for Federal actions unrelated to the action considered here. The USACE consulted with the Service for a bank stabilization and retaining wall project, bridge repairs and removal of concrete footings from two bridges at Landa Lake, and repair and installation of erosion protection for a water pipeline that crosses the Comal River. The USACE consulted with the Service for projects that impact the San Marcos system, including a stormwater outfall and the replacement of two bridges over the San Marcos River, repairs to Spring Lake Dam, and an aquatic restoration project at Spring Lake. Two consultations concerned pumping of Edwards Aquifer water by the DOD on four military installations in Bexar County. The Service also completed an intra-Service consultation regarding the pumping of Edwards Aquifer water that supports the continuing operations and refugia at the San Marcos National Fish Hatchery and Technology Center and the Uvalde National Fish Hatchery.

The incidental take of up to 4,858 fountain darters was authorized under these consultations. None of these consultations determined that the considered actions would jeopardize the fountain darter or result in destruction or adverse modification of designated critical habitat.

On May 19, 1974, the Texas Parks and Wildlife Commission placed the fountain darter on the State list of endangered species (Texas Register 1974). Section 68.002 of the TPW Code and Section 65.171 of the TAC prohibit take of an endangered species, except under a State Scientific Research or Non-game Collection Permit. "Take" is defined in Section 1.101(5) of the TPW Code as to collect, hook, hunt, net, shoot, or snare, by any means or device, and includes an attempt to take or to pursue in order to take. There are no provisions under the Texas Threatened and Endangered Species Regulations for reducing or eliminating the threats that may adversely affect the fountain darter or its habitat.

The TPWD is authorized to establish State Scientific Areas for the purposes of education, scientific research, and preservation of flora and fauna of scientific or educational value. To promote conservation of listed species and minimize the impacts of recreational activities on such species and their habitats, TPWD designated a State Scientific Area encompassing a two mile segment of the San Marcos River effective May 1, 2012.

This designation authorizes the State natural resource agency to limit recreation within designated areas when San Marcos River flows fall below 120 cfs (3.4 cms). The designation provides for continued recreational use of the waterway by maintaining open channels outside of protection zones that run the length of the river. These areas allow for continued use of the river even during low flow periods for activities such as tubing, canoeing, kayaking, and swimming.

The regulation makes it unlawful to move, deface, or alter any signage, buoys, booms, or markers delineating the boundaries of the State Scientific Area; to uproot Texas wild-rice within the area; or to enter any such marked areas. The City of San Marcos and Texas State University have committed to install kiosks at key locations identifying access points, exclusion areas, and providing educational information about the State Scientific Area and the species and habitats they are intended to conserve.

This designation includes habitat utilized by the fountain darter, and this newly enacted regulation may provide some conservation value to the species by limiting impacts from recreation during periods of low flow in the San Marcos River. However, because the State Scientific Area has only recently been established, no information has yet been collected concerning effects to listed species including the fountain darter.

The TPWD has committed to establishing a State Scientific Area in the Comal River to conserve existing and restored fountain darter habitat, though such designation has not been enacted at the time of this writing.

Critical Habitat

Critical habitat was designated on July 14, 1980, and consists of Spring Lake and its outflow and the San Marcos River downstream to 0.5 mile (0.8 km) past Interstate 35 (45 FR 47355). All designated critical habitat for the fountain darter is contained within the action area for this consultation.

The rule-making for the fountain darter predates the October 1, 1984, regulation (49 FR 38900) stipulating that primary constituent elements (PCEs) essential for the conservation of the species be identified at the time critical habitat is designated. However, the rule designating critical habitat (45 FR 47362) does describe actions that would adversely modify designated critical habitat, including any actions that would: significantly reduce aquatic vegetation in Spring Lake and the San Marcos River, impound water, excessively withdraw water, reduce flow, and pollute the water. Based on the best available scientific and commercial data available, the primary constituent elements could generally be defined as:

i. Undisturbed stream floor habitats (including runs, riffles, and pools);
ii. A mix of submergent vegetation (algae, mosses, and vascular plants);
iii. Clear and clean water;
iv. A food supply of small, living invertebrates;
v. Constant water temperatures within the natural and normal river gradients; and
vi. Adequate spring flows to maintain the conditions above.

The designated critical habitat in Spring Lake and the upper San Marcos River today provides all of the primary elements considered essential for the conservation of the fountain darter. The San

Marcos River provides a mixture of aquatic habitats including riffles, runs, and pools with a mixture of submergent vegetation, and suitable fountain dater food resources are available.

The water in Spring Lake and the San Marcos River is usually clear. Activities that contribute sediment loads, such as non-point source erosion from the urbanizing areas surrounding the upper San Marcos River, or activities that suspend existing sediments such as lake bottom disturbances by SCUBA divers in Spring Lake or swimmers in the San Marcos River, can increase turbidity and impact this element. Such turbidity in Spring Lake and the San Marcos River usually dissipate as the suspended particulates flow downstream or settle out of the water column in relation to flow rate. Continual or repeated re-suspension of particulates can markedly reduce water clarity. This can be observed downstream of popular recreation sites in the river during periods of intense use, including weekends and holidays.

Temperature at San Marcos Springs reportedly varies less than 0.9°F (0.5°C) near the headwater springs (Guyton & Associates 1979). Vaughan (1986) reported a constant springflow temperature of 70.7° F (21.5°C), with temperature ranges of 68.7°F (20.4°C) in February to 77.9°F (25.5°C) in August in the San Marcos River.

Flow rate is the result of precipitation and recharge that contribute to aquifer levels as they are affected by pumping throughout the region. Current aquifer management regulations limit pumping during drought conditions by specified amounts triggered by index well levels and springflows. These mechanisms have maintained continual springflows since they were enacted, though drought conditions during this time period have not approached the severity and duration of the DOR. As described above, existing authorized pumping volumes and regulatory schemes are not expected to provide continual springflow during a repeat of DOR-like conditions.

k. San Marcos gambusia

The entire range of the San Marcos gambusia (*Gambusia georgei)* falls within the action area and this species description therefore constitutes the environmental baseline for this species.

Species Description and Life History

The San Marcos gambusia was described from the upper San Marcos River system in 1969, and was subsequently listed as endangered on July 14, 1980 (45 FR 47355). Of the three species of *Gambusia* native to the San Marcos River, *G. georgei* has apparently always been much less abundant than either the largespring gambusia (*G. geiseri*) or the western mosquitofish (*G. affinis*) (Hubbs and Peden 1969).

The San Marcos gambusia is a member of the family Poeciliidae and belongs to a genus of Central American origin having more than 30 species of livebearing freshwater fishes. The genus *Gambusia* is well defined and mature males may be distinguished from related genera by their thickened upper pectoral fin rays (Rosen and Bailey 1963). Only a limited number of species of *Gambusia* are native to the United States, and of these the San Marcos gambusia has one of the most restricted ranges.

The food habits of *G. georgei* are unknown. Presumably, as in other poeciliids, insect larvae and other invertebrates account for most of the diet of this species.

There is little information on the reproductive capabilities of *G. georgei*. Two individuals kept in laboratory aquaria produced 12, 30, and 60 young, although the largest clutch appeared to have been aborted and did not survive (Edwards et al. 1980).

Hybridization between *G. georgei* and *G. affinis* was first noted by Hubbs and Peden (1969) and the production of hybrid individuals between them has continued for many years without obvious introgression of genetic material into either of the parental species. Given the history of hybridization between these two species, this factor was not thought to be of primary importance in considerations of the status of *G. georgei*. It was thought that so long as the proportion of hybrids remained relatively low compared to the abundance of pure *G. georgei*, few problems associated with genetic swamping or introgression would occur (Hubbs and Peden 1969, Edwards et al. 1980). However, the series of collections (Edwards, pers. comm.) taken during 1981-83 indicate that hybrid individuals may have become many times more abundant than the pure *G. georgei*. It may have been possible that hybrid individuals at that time were competing with *G. georgei*, placing an additional stress on the small native population of San Marcos gambusia.

The San Marcos gambusia apparently prefers quiet waters adjacent to moving water, but seemingly of greatest importance, thermally constant waters. *G. georgei* is found mostly over muddy substrates but generally not silted habitats, and shade from over-hanging vegetation or bridge structures is a factor common to all sites along the upper San Marcos River where apparently suitable habitats for this species occur (Hubbs and Peden 1969, Edwards et al. 1980).

Historic and Current Distribution

The San Marcos gambusia is represented in collections taken in 1884 by Jordan and Gilbert during their surveys of Texas stream fishes and in later collections (as a hybrid) taken in 1925 (Hubbs and Peden 1969). Unfortunately, records of exact sampling localities are not available for these earliest collections, as localities were merely listed as "San Marcos Springs." These collections likely were taken at or near the headsprings area. If true, then *G. georgei* appears to have significantly altered its distribution over time. For the area of the San Marcos River downstream of the headwaters area, there are few records of sampling efforts prior to 1950. However, even in the samples that were taken there are few collections of San Marcos gambusia.

A single individual was taken in 1953 below the low dam at Rio Vista Park. Almost every specimen of *G. georgei* collected since that time, however, has been taken in the vicinity of the Interstate Highway 35 Bridge crossing or shortly downstream. The single exception to this was a male taken incidentally with an Ekman dredge (sediment sampler) about 0.62 miles (1 km) below the outfall of the San Marcos wastewater treatment plant in 1974 (Longley 1975).

Historically, San Marcos gambusia populations have been extremely sparse. Intensive collections during 1978 and 1979 yielded only 18 *G. georgei* from 20,199 *Gambusia* total (0.09%) (Edwards et al. 1980). Collections made in 1981 and 1982 within the range of *G. georgei* indicated a slight decrease in relative abundance of this species (0.06% of all *Gambusia*) and none have been collected in subsequent sampling from 1982 to the present. Intensive searches for *G. georgei* were conducted in May, July, and September of 1990 but were unsuccessful in locating any pure San Marcos gambusia. The searches consisted of a total of 18 hours of effort (>180 people-hours) on three separate days and covered the area from the headwaters at Spring Lake to the San Marcos wastewater treatment plant outfall. Over 15,450 *Gambusia* were identified during the searches. One individual collected during the search was visually identified as a possible backcross of *G. affinis* and *G. georgei* (USFWS 1990 permit report). This individual was an immature fish with plain coloration. Additional sampling near the Interstate Highway 35 type locality has occurred at approximately yearly intervals since 1990 and no *G. georgei* have been found.

The pattern of San Marcos gambusia abundance strongly suggests a decrease beginning prior to the mid-1970s. The increase in hybrid abundance between *G. georgei* and *G. affinis* and the decrease in the proportion of genetically pure *G. georgei* is considered evidence of its rarity. As fewer pure individuals encountered each other, the chances of hybridization with the much more common *G. affinis* substantially increased. The subsequent decrease in San Marcos gambusia abundance along with their hybrids suggests the extinction of this species.

The San Marcos gambusia has not been collected since 1982, and may no longer exist in the wild. The species has not, however, been declared extinct or removed from the list of endangered species and must therefore be addressed in this biological opinion.

Reasons for Decline and Threats to Survival

At the time the species was listed, small and declining populations, lowered water tables, pollution, bottom plowing, and cutting of vegetation were cited as threats to the species (USFWS 1980).

Groundwater depletion, reduced springflows, contamination, habitat impacts resulting from severe drought conditions, and cumulative effects of human activities are all identified as threats to the species throughout all or a significant portion of its range (USFWS 1978, 1980).

Water quality is believed to be important to the San Marcos gambusia. Groundwater contamination or pollution resulting from a catastrophic event such as a hazardous material spill into the San Marcos River constitutes another threat to the species. The upper San Marcos River and its immediate tributaries are crossed by a total of 30 bridges including four railroad bridges and six associated with Interstate Highway 35. Any of these river crossings could be the source of a spill or release that could affect the species or its designated critical habitat in the San Marcos River. Stormwater inflows and other non-point sources of contamination may also pose a threat to the species.

Recreational use of the San Marcos River can also result in adverse impacts to the San Marcos gambusia or its habitat. Recreational uses that physically alter habitats may affect the species ability to feed and shelter.

Non-native species may threaten the San Marcos gambusia though habitat disturbance, or alteration. The San Marcos gambusia inhabits open areas with little vegetation. Suckermouth catfishes (*Loricaridae*) introduced into the San Marcos River disrupt substrates and may burrow into and destabilize riverbanks, thereby introducing additional sediment loads and turbidity into the river systems. Some researchers have hypothesized that the non-native plant Elephant ears (*Colocasia esculenta*) may have adversely affected San Marcos gambusia habitat suitability (Service 1996).

Sediment and sand bar accumulations that modify the river channel and associated habitats may also impact the species or its designated critical habitat. These sediment loads may be associated with the increasing urbanization of the lands surrounding the upper San Marcos River.

This environmental baseline describes the current status of the species and is based upon impacts to which the species has been exposed (USFWS and NMFS 1998). To understand the potential effects of the currently authorized and actual pumping amounts as managed by the existing EAA CPM plan, springflow was modeled for a 53-year period (1947 through 2000) that included a range of precipitation conditions including the DOR event that occurred from 1949 to 1956.

When total maximum permitted pumping under current regulations is modeled, San Marcos Springs are projected to cease flowing for 30 consecutive days. For comparison purposes, San Marcos Springs are not reported to have ever stopped flowing, even during the DOR event. This projected model result, though useful in understanding potential effects of the existing aquifer management scheme, does not reflect impacts that the species have experienced because these conditions have not occurred since this management plan was adopted.

Modeling the same 53-year period using actual pumping totals rather than the maximum amount of pumping permitted provides a projection that may more accurately reflect current water use, including increased efficiency of agricultural operations and increased water conservation efforts throughout the region. Actual pumping from 2000 through 2010 averaged 381,000 acre feet (469,956,586 cubic meters) per year. Modeled springflows using this recent average also project a cessation of flow at San Marcos Springs for 30 consecutive days during the repeat of DOR-like conditions (See HCP Table 4-31). This is a modeled result, and the species have not been impacted by the current pumping and management plans because the modeled drought conditions have not occurred since the current management plan was adopted. Figure 1 (above) illustrates the reported historic springflows and compares the effects of the baseline ("No Action") and the HCP (Alternatives 2a and 2b) action at San Marcos Springs. Further description of this figure is available in Section 4.2 of the EIS.

The reduction and loss of San Marcos springflows projected here during times of severe drought may represent a significant threat to the San Marcos gambusia.

Survival Needs and Recovery Criteria

The San Marcos gambusia apparently requires thermally constant water; quiet, shallow, open water adjacent to moving water; muddy substrates without appreciable quantities of silt; partial shading; clean and clear water; and a food supply of living organisms.

Elephant ears (*Colocasia esculenta*) are a non-native emergent macrophyte believed to have been introduced into the San Marcos area in the early 1900s (Akridge and Fonteyn 1981). This species has displaced native vegetation and now form extensive stands at the water's edge in the San Marcos system. Although the exact nature of the relationship between the occurrence and abundance of elephant ears and the disappearance of *G. georgei* is unknown, some investigators believe these nonnative plants may have decreased habitat suitability and contributed to its decline (Service 1996).

Academic researchers, Texas Parks and Wildlife Department scientists, and the Service have continued to search for the species in the San Marcos River. The last confirmed collection of the species was reported in 1982 (Service 1996).

Factors affecting the Species within the Action Area

The San Marcos gambusia has been the subject of two formal consultations for Federal actions unrelated to the action considered here. These consultations concerned pumping of Edwards Aquifer water by the DOD on four military installations in Bexar County. These consultations did not determine that the considered actions would jeopardize the San Marcos gambusia or result in destruction or adverse modification of designated critical habitat.

On May 15, 1976, the Texas Parks and Wildlife Commission placed the San Marcos gambusia on the State list of endangered species (Texas Register 2010). Section 68.002 of the Texas Parks and Wildlife (TPW) Code and Section 65.171 of the Texas Administrative Code (TAC) prohibit take of an endangered species, except under a State Scientific Research or Non-game Collection Permit. ''Take'' is defined in Section 1.101(5) of the TPW Code as to collect, hook, hunt, net, shoot, or snare, by any means or device, and includes an attempt to take or to pursue in order to take. There are no provisions under the Texas Threatened and Endangered Species Regulations for reducing or eliminating the threats that may adversely affect the San Marcos gambusia or its habitat.

Critical Habitat

Designated critical habitat for the San Marcos gambusia is described as the San Marcos River from Highway 12 Bridge downstream to approximately 0.5 miles below Interstate Highway 35 Bridge (45 FR 47355). The designated critical habitat for the San Marcos gambusia is wholly contained within the described action area for this consultation.

The rule-making for the San Marcos gambusia predates the October 1, 1984, regulation (49 FR 38900) stipulating that primary constituent elements (PCEs) essential for the conservation of the species be identified at the time critical habitat is designated. However, the rule describes actions that would adversely modify designated critical habitat, including those that would result in an increase in vegetation in the species' preferred open areas with little current away from stream banks, disrupt the mud bottom, or alter the temperature regime. Based on the best available scientific and commercial data available, the primary constituent elements could generally be defined as:

i. Open areas with little current or vegetation away from stream banks;
ii. Maintenance of natural substrates; and
iii. A natural temperature regime in occupied areas of the San Marcos River.

The designated critical habitat in the San Marcos River generally provides the primary elements considered essential for the conservation of the San Marcos gambusia. The San Marcos River provides a mixture of aquatic habitats including open areas away from stream banks with little vegetation. Bottom substrates in the designated critical habitat unit in the San Marcos River have been impacted by siltation and sediments, though areas with natural substrates still exist. Water temperature in the San Marcos River remains within the ranges of 68.7°F (20.4°C) in February to 77.9°F (25.5°C) in August (Vaughan 1896).

l. San Marcos salamander

The entire range of the San Marcos salamander (*Eurycea nana*) is within the action area, and this species description therefore constitutes the environmental baseline for the species.

Species Description and Life History

The San Marcos salamander was listed as threatened on July 14, 1980 (45 FR 47355). This dark reddish-brown slender salamander reaches lengths of one to two inches (2.5 to 5 cm), and has moderately large eyes with a dark ring around the lens. The species has well developed and highly pigmented gills, relatively short, slender limbs with four toes on the fore feet and five on the hind feet. San Marcos salamanders have a slender tail with a well-developed dorsal fin (Service 1996).

The San Marcos salamander is a member of the family Plethodontidae (lung-less salamanders) and is a neotenic salamander that retains its external gills (the larval condition) throughout life (Bishop 1941). The salamander does not leave the water to metamorphose into a terrestrial form, but instead becomes sexually mature and breeds in the water. Most evidence suggests reproduction occurs throughout the year with a possible peak about May and June (Service 1996).

Habitat consists of algal mats (Tupa and Davis 1967), where rocks are associated with spring openings (Nelson 1993). Sandy substrates devoid of vegetation and muddy silt or detritus-laden substrates with or without vegetation are apparently unsuitable habitats for this species. Specimens are occasionally collected from beneath stones in predominantly sand and gravel areas. In view of the abundance of predators (primarily larger fish, but also crayfish, turtles, and aquatic birds) in the immediate vicinity of spring orifices, protective cover such as that afforded by algal mats and rocks is essential to the survival of the salamander. The flowing spring waters in the principal habitat are near neutral (pH 6.7-7.2), range from 69.8-73.4°F (21 to 23°C), clear, and dissolved oxygen levels are low (less than 50% saturated, 3-4 mg/L (Tupa and Davis 1967, Najvar 2001, Guyton and Associates 1979, Groeger et al. 1997).

Prey items for the San Marcos salamander include amphipods, tendipedid (midge fly) larvae and pupae, other small insect pupae and naiads (an aquatic life Stage of mayflies, dragonflies, damselflies, and stone flies), and small aquatic snails (Service 1996a).

Historic and Current Distribution

A total of 20 San Marcos salamanders were collected from San Marcos Springs on 22 June 1938 (Bishop 1941). Subsequent researchers found the species near all of the major spring openings scattered throughout Spring Lake and downstream as far as 500 feet below Spring Lake dam (Tupa and Davis 1976, Nelson 1993, BIO-WEST 2010).

Population estimates for the San Marcos salamander have ranged from 17,000 to 21,000 individuals in the floating algal mats at the uppermost portion of Spring Lake (Tupa and Davis 1976), to as many as 53,200 salamanders from Spring Lake and the rocky substrates within approximately 500 feet (152 meters) downstream of the Spring Lake Dams (Nelson 1993). Seven-years of quarterly monitoring of San Marcos salamander populations using visual surveys by divers showed stable visual counts (BIO-WEST 2010).

One difficulty in estimating San Marcos salamander populations is the small size of young salamanders and their ability to move undetected into interstitial spaces among the substrate. Tupa and Davis (1976) and Nelson (1993) estimated the number of San Marcos salamanders in and near Spring Lake and found them distributed throughout Spring Lake among rocks near spring openings, in algal mats, mosses, and other plants, and in rocky areas just downstream from the dams (Nelson 1993; BIO-WEST 2007d, 2010). The species occurs near all of the major spring openings scattered throughout Spring Lake and is abundant at some of these springs (Nelson 1993). Nelson (1993) estimated a total population of 53,200 salamanders in and just below Spring Lake, including 23,000 associated with algal mats, 25,000 among rocky substrates around spring openings, and 5,200 in rocky substrates below Spring Lake.

San Marcos salamander density estimates based on 21 sampling rounds since the fall of 2000 indicate that the size of the current salamander population appears to be thriving and generally similar to observations made over the previous eight-years of sampling (BIO-WEST 2010).

Reasons for Decline and Threats to Survival

The primary threats to the San Marcos salamander are related to the quality and quantity of aquifer and spring water. The restricted distribution of the species, loss of protective cover, contaminants, siltation, and introduced predators may also threaten the species (45 FR 47355, Service 1996a).

Groundwater contamination or pollution resulting from a catastrophic event such as a hazardous material spill into Spring Lake or one of its tributaries could threaten the San Marcos salamander or its designated critical habitat. Spring Lake, its tributaries, and the portion of the San Marcos known to be occupied by the species are crossed by six bridges. Stormwater and other non-point sources could also contribute pollutants that could threaten the species or affect its habitat.

Sediment and siltation in Spring Lake and the uppermost portions of the San Marcos River may also impact the species or its habitat. These sediment loads may be associated with the increasing urbanization of the lands surrounding the upper San Marcos River.

This environmental baseline describes the current status of the species and is based upon impacts to which the species has been exposed (USFWS and NMFS 1998). To understand the potential effects of the currently authorized and actual pumping amounts as managed by the existing EAA CPM plan, springflow was modeled for a 53-year period (1947 through 2000) that included a range of precipitation conditions including the DOR event that occurred from 1949 to 1956.

When total maximum permitted pumping under current regulations is modeled, San Marcos Springs are projected to cease flowing for 30 consecutive days. For comparison purposes, San Marcos Springs are not reported to have ever stopped flowing, even during the DOR event. This projected model result, though useful in understanding potential effects of the existing aquifer management scheme, does not reflect impacts that the species have experienced because these conditions have not occurred since this management plan was adopted.

Modeling the same 53-year period using actual pumping totals rather than the maximum amount of pumping permitted provides a projection that may more accurately reflect current water use, including increased efficiency of agricultural operations and increased water conservation efforts throughout the region. Actual pumping from 2000 through 2010 averaged 381,000 acre feet (469,956,586 cubic meters) per year. Modeled springflows using this recent average also project a cessation of flow at San Marcos Springs for 30 consecutive days during the repeat of DOR-like conditions (See HCP Table 4-31). This is a modeled result, and the species have not been impacted by the current pumping and management plans because the modeled drought conditions have not occurred since the current management plan was adopted. Figure 1 (above) illustrates the reported historic springflows and compares the effects of the baseline ("No Action") and the HCP (Alternatives 2a and 2b) action at San Marcos Springs. Further description of these figures is available in Section 4.2 of the EIS.

The reduction and loss of San Marcos springflows projected here during times of severe drought could significantly affect the San Marcos salamander.

Survival Needs and Recovery Criteria

The San Marcos salamander recovery needs are addressed in the San Marcos and Comal Springs and Associated Aquatic Ecosystems Recovery Plan (USFWS 1996). Recovery tasks identified in the plan include: ensuring adequate flows and water quality in San Marcos Springs and the San Marcos River; maintenance of genetically diverse reproductive populations in captivity and creation of reintroduction techniques for use in the event of a catastrophic event; removal or reduction of threats due to non-native species, recreational use of the river, and habitat alteration; and maintenance of healthy, self-sustaining, reproductive populations in the wild.

The Service's San Marcos Aquatic Resource Center (formerly the San Marcos National Fish Hatchery and Technology Center) has developed captive breeding techniques for San Marcos salamander in the event that the natural population at San Marcos Springs is lost. The facility successfully produced more than 5,000 eggs by 2009, with an average hatch success at about 20 percent. Reproduction of this species, however, remains unpredictable (J. N. Fries, 2009, pers. obs., Service, San Marcos, Texas). Techniques for maintaining this species' genetic diversity have been improved over the past several years. The ability to maintain this species in captivity (without supplemental wild caught individuals) over the long-term remains uncertain (Fries 2002). Reintroduction techniques have yet to be developed.

Factors affecting the Species within the Action Area

The San Marcos salamander has been addressed in five formal consultations for Federal actions unrelated to the action currently under consideration. The USACE consulted with the Service for repairs to Spring Lake Dam, and an aquatic restoration project at Spring Lake. Two consultations concerned pumping of Edwards Aquifer water by the DOD on four military installations in Bexar County. The Service also completed an intra-Service consultation regarding the pumping of Edwards Aquifer water that supports the continuing operations and refugia at the San Marcos National Fish Hatchery and Technology Center and the Uvalde National Fish Hatchery.

The incidental take of 842 San Marcos salamanders was authorized under these consultations. None of these consultations resulted in a determination that the considered actions would jeopardize the species or result in destruction or adverse modification of designated critical habitat.

On July 18, 1977, the Texas Parks and Wildlife Commission placed the San Marcos salamander on the State list of threatened species (Texas Register 2010). Section 68.002 of the Texas Parks and Wildlife (TPW) Code and Section 65.171 of the Texas Administrative Code (TAC) prohibit take of threatened species, except under a State Scientific Research or Non-game Collection Permit. ''Take'' is defined in Section 1.101(5) of the TPW Code as to collect, hook, hunt, net, shoot, or snare, by any means or device, and includes an attempt to take or to pursue in order to take. There are no provisions under the Texas Threatened and Endangered Species Regulations for reducing or eliminating the threats that may adversely affect the San Marcos salamander or its habitat.

The TPWD is authorized to establish State Scientific Areas for the purposes of education, scientific research, and preservation of flora and fauna of scientific or educational value. To promote conservation of listed species and minimize the impacts of recreational activities on such species and their habitats, TPWD designated a State Scientific Area encompassing a two mile segment of the San Marcos River effective May 1, 2012.

This designation authorizes the State natural resource agency to limit recreation within designated areas when San Marcos River flows fall below 120 cfs. The designation provides for continued recreational use of the waterway by maintaining open channels outside of protection zones that run the length of the river. These areas allow for continued use of the river even during low flow periods for activities such as tubing, canoeing, kayaking, and swimming.

The regulation makes it unlawful to move, deface, or alter any signage, buoys, booms, or markers delineating the boundaries of the State Scientific Area; to uproot Texas wild-rice within the area; or to enter any such marked areas. The City of San Marcos and Texas State University have committed to install kiosks at key locations identifying access points, exclusion areas, and providing educational information about the State Scientific Area and the species and habitats they are intended to conserve.

This designation includes habitat utilized by the San Marcos salamander, and this newly enacted regulation may provide some conservation value to the species by limiting impacts from recreation during periods of low flow in the San Marcos River. However, because the State Scientific Area has only recently been established, no information has yet been collected concerning effects to listed species including the San Marcos salamander.

Critical Habitat

Critical habitat for the San Marcos salamander was designated on July 14, 1980, and is described as: Spring Lake and its outflow, the San Marcos River, downstream approximately 164 feet (50 meters) below Spring Lake dam (45 FR 47362). All designated critical habitat for this species is within the action area considered in this consultation.

The critical habitat designation for San Marcos salamander predates the requirement for identification of primary constituent elements essential for the conservation of the species. However, the rule designating critical habitat (45 FR 47362) describes actions that would adversely modify designated critical habitat, including those that would: lower the water table; expose algal mats, leading to the desiccation of the species sole habitat; and disturb algal mats or the bottom of the lake, such as from SCUBA divers. Based on the best available scientific and commercial data, the primary constituent elements could generally be defined as:

i. Thermally constant waters;
ii. Flowing water;
iii. Clean and clear water;
iv. Sand, gravel, and rock substrates with little mud or detritus; and
v. Vegetation or rocks for cover.

The designated critical habitat in Spring Lake and the upper San Marcos River today provides all of the primary elements considered essential for the conservation of the San Marcos salamander.

Temperature at San Marcos Springs reportedly varies less than 0.9°F (0.5°C) near the headwater springs (Guyton & Associates 1979). Vaughan (1986) reported a constant springflow temperature of 70.7°F, with temperature ranges of 68.7°F (20.4°C) in February to 77.9° F (25.5°C) in August in the San Marcos River.

Flow rate is the result of precipitation and recharge that contribute to aquifer levels as they are affected by pumping throughout the region. Current aquifer management regulations limit pumping during drought conditions by specified amounts triggered by index well levels and springflows. These mechanisms have maintained continual springflows since they were enacted, though drought conditions during this time period have not approached the severity and duration of the DOR. As described above, existing authorized pumping volumes and regulatory mechanisms are not expected to provide continual springflow during a repeat of DOR-like conditions.

The water in Spring Lake and the San Marcos River is usually clear. Activities that contribute sediment loads, such as non-point source erosion from the urbanizing areas surrounding the upper San Marcos River, or activities that suspend existing sediments such as lake bottom disturbances by SCUBA divers in Spring Lake or swimmers in the San Marcos River, can increase turbidity and impact this element. Such turbidity in Spring Lake and the San Marcos River usually dissipate as the suspended particulates flow downstream or settle out of the water column in relation to flow rate. Continual or repeated re-suspension of particulates can markedly reduce water clarity. This can be observed downstream of popular recreation sites in the river during periods of intense use, such as during weekends and holidays.

Though some siltation and sedimentation of natural substrates has occurred, sand, grave, and rock substrates with little mud or detritus are available. Vegetation and rocky cover is present in both Spring Lake, and rocky cover types predominate in the uppermost designated portions of the San Marcos River.

m. Texas blind salamander

The entire range of the Texas blind salamander (*Typhlomolge [=Eurycea] rathbuni*) is within the action area considered here, and the species status therefore constitutes the environmental baseline for the species.

Species Description and Life History

The Texas blind salamander was listed as endangered on March 11, 1967 under the Endangered Species Preservation Act of 1966 (32 FR 4001). The species was subsequently incorporated into the list of species threatened with extinction on October 13, 1970 (35 FR 16047) after the passage of the Endangered Species Conservation Act of 1969, and was again confirmed as an endangered species on September 26, 1975 (40 FR 44412) after the Endangered Species Act of 1973 superseded the earlier endangered species statues.

The Texas blind salamander is a smooth, unpigmented, stygobitic (obligate aquatic cave-adapted) species. Adults attain an average length of about 4.7 inches (12 cm) with a large, broad head, and reduced eyes. The limbs are slender and long with four toes on the fore feet and five toes on the hind feet (Longley 1978). The Texas blind salamander is a neotenic species believed to be adapted to the relatively constant temperatures (69.8°F [21°C]) of the water-filled subterranean caverns of the Edwards Aquifer in the San Marcos area (Longley 1978).

Juveniles have been collected throughout the year, making it likely that this species is sexually active year-round (Longley 1978). The species does not have reliable external characters that can be used to distinguish between the sexes (Service 1996).

The Texas blind salamander is an active predator. It moves its head from side to side as it searches for food and hunts by sensing water pressure waves created by prey in the still underground waters where it lives. Prey items include amphipods, blind shrimp (*Palaemonetes antrorum*), daphnia, small snails, and other invertebrates. Observations of captive individuals indicate that Texas blind salamanders feed indiscriminately on small aquatic organisms and do not appear to exhibit an appreciable degree of food selectivity.

Observations indicate that this salamander moves through the aquifer by traveling along submerged ledges and may swim short distances before spreading its legs and settling to the bottom of the pool (Longley 1978).

Historic and Current Distribution

The Texas blind salamander was first collected in 1895 from an artesian well drilled to supply water to the U. S. Fish Commission Hatchery in San Marcos, Texas (Longley 1978). The species has subsequently been collected at several other locations within Hays County, including Ezell's Cave, San Marcos Springs, Rattlesnake Cave, Primer's Fissure, Texas State University's artesian well, and Frank Johnson's well (Russell 1976, Longley 1978). The species was collected at Wonder Cave in 1917 (Uhlenhuth 1921) (also known as Beaver Cave), though searches in 1977 did not confirm any specimens at that location (Longley 1978). The known range of the Texas blind salamander has not changed since listing in 1967.

Reasons for Decline and Threats to Survival

Threats to the Texas blind salamander identified in the San Marcos and Comal Springs and Associated Aquatic Ecosystems Recovery Plan (USFWS 1996) include loss of springflows due to decreases in aquifer levels; water quality declines (including a loss of historically stable thermal conditions); human modifications (such as bank stabilization, dams, and landowner maintenance activities in waterways and on adjacent tracts of land) that have changed the historical magnitude and occurrence of episodic events such as flooding, and indirect impacts from surrounding development and urbanization; and introduction of non-native species.

This environmental baseline describes the current status of the species and is based upon impacts to which the species has been exposed (USFWS and NMFS 1998). To understand the potential effects of the currently authorized and actual pumping amounts as managed by the existing EAA CPM plan, springflow was modeled for a 53-year period (1947 through 2000) that included a range of precipitation conditions including the DOR event that occurred from 1949 to 1956.

When total maximum permitted pumping under current regulations is modeled, San Marcos Springs are projected to stop flowing for 30 consecutive days. For comparison, San Marcos Springs are not recorded to have ever stopped flowing. This projected model result, though useful in understanding potential effects of the existing aquifer management scheme, does not reflect impacts that the species have experienced because these conditions have not occurred since this management plan was adopted.

Modeling the same 53-year period using actual pumping totals rather than the maximum amount of pumping permitted provides a projection that may more accurately reflect current water use, including increased efficiency of agricultural operations and increased water conservation efforts throughout the region. Actual pumping from 2000 through 2010 averaged 381,000 acre feet (469,956,586 cubic meters) per year. Modeled San Marcos springflows using this recent average also projects that San Marcos springflows will cease for 30 consecutive days during a repeat of DOR-like conditions (See HCP Table 4-30 and 4-31). This is a modeled result, and the species have not been impacted by the current pumping and management plans because the modeled drought conditions have not occurred since the current management plan was adopted. Figure 1 (above) illustrates the reported historic springflows and compares the effects of the baseline ("No Action") and the HCP (Alternatives 2a and 2b) action at San Marcos Springs. Further description of this figure is available in Section 4.2 of the EIS.

Springflows are a function of aquifer level, and the reduction and loss of springflows projected by these modeling efforts during severe drought conditions suggests lowered aquifer levels. Given the Texas blind salamander's apparent restriction to the waters of the aquifer in Hays County, these lowered aquifer levels may represent impacts to the species and its habitat.

Survival Needs and Recovery Criteria

Recovery tasks identified in the San Marcos and Comal Springs and Associated Aquatic Ecosystems Recovery Plan (Service 1996a) include: assuring adequate water levels and water quality in the aquifer, establishment of captive breeding populations with sufficient genetic integrity and development of reintroduction techniques, addressing local threats to water quality and quantity, and ensuring that self-sustaining populations of the species exist throughout its range.

Little is known about the population size or trends in population for this species and no reliable estimates are available. The species' range has been hypothesized to be as small as 39 square miles beneath and near the city of San Marcos (Longley 1978).

Factors affecting the Species within the Action Area

The Texas blind salamander has been the subject of three formal consultations for Federal actions unrelated to the action considered here. These consultations concerned pumping of Edwards Aquifer water by the DOD on four military installations in Bexar County, and an intra-Service consultation addressing the continuing operations and refugia at the San Marcos National Fish Hatchery and Technology Center and the Uvalde National Fish Hatchery. These consultations did not determine that the considered actions would jeopardize the Texas blind salamander.

On May 19, 1974, the Texas Parks and Wildlife Commission placed the Texas blind salamander on the State list of endangered species (Texas Register 2010). Section 68.002 of the Texas Parks and Wildlife (TPW) Code and Section 65.171 of the Texas Administrative Code (TAC) prohibit take of an endangered species, except under a State Scientific Research or Non-game Collection Permit. ''Take'' is defined in Section 1.101(5) of the TPW Code as to collect, hook, hunt, net, shoot, or snare, by any means or device, and includes an attempt to take or to pursue in order to take. There are no provisions under the Texas Threatened and Endangered Species Regulations for reducing or eliminating the threats that may adversely affect the Texas blind salamander or its habitat.

Critical Habitat

Critical habitat has not been designated for the Texas blind salamander.

n. Comal Springs salamander

The entire range of the Comal Springs salamander (*Eurycea* sp.) is within the action area considered here, and the species status therefore constitutes the environmental baseline for the species.

Species Description and Life History

The Comal Springs salamander (*Eurycea* sp.) is a currently undescribed Plethodontid salamander known from Comal Springs. The taxonomic status of this salamander has been the subject of some debate, and has yet to be resolved. In his dissertation on *Eurycea* salamanders in Texas, Sweet assigned most of the spring and cave salamanders found north of the Balcones Escarpment to the species *Eurycea neotenes*, though he suggested that the Comal Springs salamander might represent a population of the San Marcos salamander (Sweet 1978).

Biochemical, molecular, and morphometric studies later clarified that the Comal Springs salamander is not a conspecific of the San Marcos salamander, but indicates that the Comal salamander shares an allele with the Texas blind salamander (Chippendale et al. 1990, 1992, 1993, 1994). Efforts to date have yet to determine the status of this salamander.

One individual collected in the wild survived in captivity at the San Marcos National Fish Hatchery and Technology Center for more than eight years (J. Fries, pers. Com.). No information is available about longevity of the species in the wild.

For the purposes of the action and the analysis of effects, the Comal Springs salamander is presumed to represent a unique species.

Historic and Current Distribution

The Comal Springs salamander is only known to occur in Comal Springs in Landa Park and Landa Lake (74 FR 66866).

Reasons for Decline and Threats to Survival

The Service cited the present or threatened destruction, modification, or curtailment of habitat or range resulting from groundwater withdrawal and groundwater contamination as potential threats to the species in a 90-day finding on a petition to list the species as threatened or endangered (74 FR 66866). In this finding, the Service determined that listing the species as threatened or endangered may be warranted.

The Comal Springs salamander is only known from Landa Lake, and the species is presumed to have survived the DOR though there are no records of species abundance and distribution before, during, or immediately after the DOR event.

Pollution such as groundwater contamination or as the result of a catastrophic event such as a hazardous material spill or other release within the watershed or into Landa Lake or its immediate tributaries constitutes a threat to the species. Landa Lake and its immediate tributaries are crossed by a total of five bridges, any of which could be the source of a spill that could affect the species. Stormwater inflows and other non-point sources of contamination may also pose a threat to the species.

This environmental baseline describes the current status of the species and is based upon impacts to which the species has been exposed (USFWS and NMFS 1998). To understand the potential effects of the currently authorized and actual pumping amounts as managed by the existing EAA CPM plan, springflow was modeled for a 53-year period (1947 through 2000) that included a range of precipitation conditions including the DOR event that occurred from 1949 to 1956.

When total maximum permitted pumping under current regulations is modeled, Comal Springs are projected to cease flowing for 38-months. For comparison purposes, San Marcos Springs are not recorded to have ever stopped flowing, even during the DOR. This projected model result, though useful in understanding potential effects of the existing aquifer management scheme, does not reflect impacts that the species have experienced because these conditions have not occurred since this management plan was adopted.

Modeling the same 53-year period using actual pumping totals rather than the maximum amount of pumping permitted provides a projection that may more accurately reflect current water use, including increased efficiency of agricultural operations and increased water conservation efforts throughout the region. Actual pumping from 2000 through 2010 averaged 381,000 acre feet (469,956,586 cubic meters) per year. Modeled Comal springflows using this recent average also projects that Comal Springs will cease flowing for 36-months during a repeat of DOR-like conditions (See HCP Table 4-30). This is a modeled result, and the species have not been impacted by the current pumping and management plans because the modeled drought conditions have not occurred since the current management plan was adopted. Figure 2 (above) illustrates the reported historic springflows and compares the effects of the baseline ("No Action") and the HCP (Alternatives 2a and 2b) action at Comal Springs. Further description of this figure is available in Section 4.2 of the EIS.

The reduction and loss of springflows projected to occur during severe drought conditions could have significant impacts to the Comal Springs salamander.

Survival Needs and Recovery Criteria

Though little is yet known about the specific survival needs for this species, the habitats in which Comal Springs salamanders are found suggest that there may be similarities with the needs described for the related San Marcos salamander, including adequate flows and water quality in Comal Springs and the Comal River; removal or reduction of threats due to non-native species, recreational use of the river, and habitat alteration; and maintenance of healthy, self-sustaining, reproductive populations in the wild.

The Comal Springs salamander has not been listed as threatened or endangered, and no Recovery Criteria have been established.

Factors affecting the Species within the Action Area

No consultations that consider potential impacts to this species have previously been completed.

Critical Habitat

The Comal Springs salamander is not currently listed as threatened or endangered, and therefore no critical habitat has been designated for this species.

o. Whooping Crane

The range of the Whooping Crane (*Grus americana*) extends beyond the action area, and this species description therefore describes both the rangewide status as well as those populations that may be affected by the proposed action.

Species Description and Life History

The Whooping Crane was listed as endangered on March 11, 1967, under the Endangered Species Preservation Act of 1966 (32 FR 4001). The species was subsequently incorporated into the list of endangered foreign fish and wildlife on June 2, 1970 (35 FR 8491) after the passage of the Endangered Species Conservation Act of 1969.

The Whooping Crane is the tallest North American bird and males, which are larger than females, may reach nearly 5 feet (1.5 meters). The life span in the wild is estimated to be 22 to 24-years (Campbell 2003, Canadian Wildlife Service [CWS] and the Service 2007, Lewis 1995).

Whooping cranes may start nesting as early as 3-years of age (Kuyt and Goossen 1987; Brian Johns, CWS, pers. comm.). However the average age of first egg production is 5-years (Kuyt and Goossen 1987). Pair formation can occur rapidly or be a lengthy process (Bishop 1984, Stehn 1997). Whooping cranes are monogamous, but will re-pair, sometimes within only a few days, following the death of their mate (Blankinship 1976, Stehn 1992a, 1997). Experienced pairs arrive at their breeding grounds in late April and begin nest construction. They show considerable fidelity to their breeding territories, and normally nest in the same general vicinity each year. From the initiation of egg laying until chicks are a few months of age, the activities of pairs and family groups are restricted to the breeding territory.

Autumn migration normally begins in mid-September, with most birds arriving on the wintering grounds between late October and mid-November. Occasionally, stragglers may not arrive until late December. Whooping cranes migrate south as singles, pairs, in family groups, or as small flocks of 3 to 5 birds (Johns 1992). They are diurnal migrants, flying during the day and resting at night, and make regular stops to feed and rest. Large groups of up to 20 sometimes use the same stopover location. Pairs with young are among the last to leave the breeding range (Allen 1952, Archibald *et al.* 1976, Stephen 1979).

Whooping cranes are known to utilize a variety of habitat types during migration, including freshwater marshes, wet prairies, inland lakes, small farm ponds, upland grain fields, and riverine systems. Shallow flooded palustrine wetlands are used for roosting, while croplands and emergent wetlands are used for feeding. Riverine habitats, such as submerged sandbars, are often used for roosting as well. Most wetlands used for roosting are within 0.62 mile of a suitable feeding area (Armbruster 1990; Campbell 2003; CWS and the Service 2007; Howe 1987, 1989; Lewis 1995; Lingle *et al.* 1991). The whooping crane's principal wintering habitat consists primarily of brackish bays, marshes, and salt flats, but they will also forage on interior uplands (Campbell 2003, CWS and Service 2007, Lewis 1995).

As spring approaches, mating or "dancing" behavior (running, leaping, and bowing; unison calling; and flying) increases in frequency, and is indicative of pre-migratory restlessness (Allen 1952, Blankinship 1976, Stehn 1992b). Family groups and pairs are usually among the first to depart wintering grounds, often assisted by seasonal strong southeast winds. First departure dates are normally between March 25 and April 15, with the last birds usually leaving by May 1. Occasional stragglers may linger into mid-May, and in 19-years, from 1938-2005, 1 to 4 birds (34 birds total) have remained on the wintering grounds throughout the summer. Parents separate from their young of the previous year upon departure, in northward migration while in route to the breeding grounds, or soon after arrival on the breeding grounds (Allen 1952, Stehn 1992c, B. Johns, CWS, pers. comm.).

Historic and Current Distribution

Current evidence indicates that the species' historical range extended from the Arctic coast south to central Mexico, and from Utah east to New Jersey, South Carolina, Georgia, and Florida (Allen 1952, Nesbitt 1982). The major nesting area during the 19th and 20th centuries extended from central Illinois, northwestern Iowa, northwestern Minnesota, and northeastern North Dakota northwesterly through southwestern Manitoba, southern Saskatchewan, and into east central Alberta (Allen 1952). Some nesting apparently occurred at other sites such as Wyoming in the 1900's, but documentation is limited (Kemsies 1930, Allen 1952). Allen (1952) believed the whooping crane's principal wintering range was the tall grass prairies, in southwestern Louisiana, along the Gulf Coast of Texas, and in northeastern Mexico near the Rio Grande Delta. Other significant wintering areas were the interior tablelands in western Texas and the high plateaus of central Mexico, where whooping cranes occurred among thousands of sandhill cranes.

In the 19th century, there were several migration routes. The two most important were "...those between Louisiana and the nesting grounds in Illinois, Iowa, Minnesota, North Dakota, Manitoba, and the other from Texas and the Rio Grande Delta region of Mexico to nesting grounds in North Dakota, the Canadian Provinces, and Northwest Territories" (Allen 1952:103). A route through west Texas into Mexico apparently followed the route still used by sandhill cranes, and it is believed the whooping cranes regularly traveled with them to wintering areas in the central interior highlands region (Allen 1952). Another migration route crossed the Appalachians to the Atlantic Coast. These birds apparently nested in the Hudson Bay area of Canada.

Whooping cranes currently occur only in North America within Canada and the United States. Approximately 83 percent of the wild nesting sites occur in Canada and 17 percent occur in Florida and Wisconsin. There is only one self-sustaining wild population and it nests in the Northwest Territories and adjacent areas of Alberta, Canada, primarily within the boundary of Wood Buffalo National Park (WBNP, Johns 1998). These cranes migrate southeasterly through Alberta, Saskatchewan, and eastern Manitoba, stopping in southern Saskatchewan for several weeks in fall migration before continuing migration into the United States. They migrate through the Great Plains States of eastern Montana, North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, and Texas. They winter along the Gulf of Mexico coast at Aransas National Wildlife Refuge (ANWR) and adjacent areas in estuarine marshes, shallow bays, and tidal flats (Allen 1952, Blankinship 1976). Some individuals occur occasionally on nearby privately owned pasture or croplands.

Allen (1952) estimated that the whooping crane population in "... 1860, or possibly 1870, totaled between 1,300 and 1,400 individuals." Banks (1978), using 2 independent techniques, derived estimates of 500 to 700 whooping cranes present in 1870. The whooping crane disappeared from the heart of its breeding range in the north-central United States by the 1890s.

By 1944 only 21 birds remained in 2 small breeding populations: a non-migratory population that inhabited the area around White Lake in southwestern Louisiana, and the migratory Aransas-Wood Buffalo population. The last reported reproduction in the non-migratory Louisiana population occurred in 1939 (Lynch 1956, Gomez 1992, Drewien *et al.* 2001). In March, 1950, the Louisiana population ceased to exist as the last individual was captured and turned loose at Aransas, but did not survive the summer.

In 2011, 281whooping cranes, a record number, occurred in the Aransas-Wood Buffalo population (O'Brian 2011). The second population of wild whooping cranes is non-migratory (Nesbitt *et al.* 1997) and occurs in central Florida. This population was first reintroduced in 1993. Approximately 59 birds survived in February 2006, from 289 captive-reared whooping cranes released over a 13-year period. A third population of wild whooping cranes is migratory and was reintroduced starting in 2001. This population migrates from the Necedah NWR in central Wisconsin to Chassahowitzka NWR, a 30,800 acres expanse of salt marsh on the Gulf Coast of Florida. As of 2011, this population numbered 110 birds. There are also approximately 167 whooping cranes in captivity, mostly at Patuxent Research Refuge, Maryland (O'Brian 2011).

Whooping Cranes are found within the action area during the period when they winter along the Gulf of Mexico coast at ANWR and adjacent areas in estuarine marshes, shallow bays, and tidal flats.

Reasons for Decline and Threats to Survival

Hunting was one of the primary reasons for the whooping crane's historical decline. Human-caused mortality of cranes declined following enactment of protective legislation. Although hunting whooping cranes is now illegal, shootings occasionally occur (Lewis *et al.* 1992).

The growth of the human population in North America has resulted in significant whooping crane habitat alteration and destruction. Conversion of potholes and prairies to hay and grain production made much of the historic nesting habitat unsuitable for whooping cranes. Disruptive practices included draining, fencing, sowing, and the human activity associated with these actions. Settlement of the mid-continent and coastal prairies and associated disturbance, in addition to alteration of habitat, may have interfered with continued use of prairie and wetlands by breeding whooping cranes. The extensive drainage of wetlands in the prairie pothole region of Canada and the United States also resulted in a tremendous loss of migration habitat available to whooping cranes. Water diversions on major river systems, such as the Platte River, have degraded migration habitat.

Currently, expanding human populations throughout the range of the whooping cranes continue to threaten survival and recovery of the birds. Impacts are particularly severe on the wintering grounds. Freshwater inflows starting more than a hundred miles inland, primarily from the Guadalupe and San Antonio rivers, flow into whooping crane critical habitat at ANWR; these inflows are needed to maintain proper salinity gradients, nutrient loadings, and sediments that produce an ecologically healthy estuary (TPWD 1998). Spring flows originating from the Edwards Aquifer are also crucial, especially in times of drought when they can make up 70 percent of Guadalupe River water. Inflows are essential to maintaining the productivity of coastal waters and produce foods used by whooping cranes. Coastal waters with low saline levels are maintained by these in-stream flows, providing drinking water for cranes that would otherwise fly inland for freshwater.

Collisions with power lines are a substantial cause of whooping crane mortality in migration (Brown *et al.* 1987, Lewis *et al.* 1992). Collisions with power lines are responsible for the death or serious injury of at least 44 whooping cranes since 1956. In the 1980s, two of nine radio-marked whooping cranes from the Aransas-Wood Buffalo population died within the first 18-months of life as a result of power line collisions (Kuyt 1992). Of 27 documented mortalities in the reintroduced Rocky Mountain population, which is now extirpated, almost two-thirds were due to collisions with power lines (40.1 percent) and wire fences (22.2 percent) (Brown *et al.* 1987). Twenty individuals within the Florida populations and two individuals in the migratory Wisconsin population have died hitting power lines.

Other threats include the increased risk of disease exposure and transmission, due to the concentration of birds using the limited available wetlands; increased disturbance to whooping cranes on the wintering grounds; climate change, which can prolong drought and reduce freshwater flows; and the potential for catastrophic chemical spills or hurricanes.

The status of the species described here is based upon impacts to which the species has been exposed. To understand the potential effects of the currently authorized and actual pumping amounts as managed by the existing EAA CPM plan, springflow was modeled for a 53-year period (1947 through 2000) that included a range of precipitation conditions including the DOR event that occurred from 1949 to 1956.

When total maximum permitted pumping under current regulations is modeled, Comal Springs are projected to cease flowing for 38-months and San Marcos Springs are projected to stop flowing for 30 consecutive days. For comparison, during the 1949 to 1956 DOR, Comal Springs ceased flowing for four-months, and San Marcos Springs are not recorded to have ever stopped flowing. This projected model result, though useful in understanding potential effects of the existing aquifer management scheme, does not reflect impacts that the species have experienced because these conditions have not occurred since this management plan was adopted.

Modeling the same 53-year period using actual pumping totals rather than the maximum amount of pumping permitted provides a projection that may more accurately reflect current water use, including increased efficiency of agricultural operations and increased water conservation efforts throughout the region. Actual pumping from 2000 through 2010 averaged 381,000 acre feet (469,956,586 cubic meters) per year. Modeled Comal springflows using this recent average also projects that Comal Springs will cease flowing for 36-months, and San Marcos springflows stop flowing for 30 consecutive days during a repeat of DOR-like conditions (See HCP Table 4-30 and 4-31). This is a modeled result, and the species have not been impacted by the current pumping and management plans because the modeled drought conditions have not occurred since the current management plan was adopted. Figures 1 and 2 (above) illustrate the reported historic springflows and compare the effects of the baseline ("No Action") and the HCP (Alternatives 2a and 2b) action at San Marcos Springs and Comal Springs, respectively. Further description of these illustrations is available in Section 4.2 of the EIS.

Because Comal and San Marcos springflows flow into the Guadalupe River, and therefore contribute to the freshwater inputs vital to maintaining suitable wintering habitat for the Whooping Crane, the reduction and loss of springflows projected by these modeling efforts could impact the species during severe drought conditions similar to those observed in 2010 and 2011.

Survival Needs and Recovery Criteria

The Whooping Crane Recovery Plan (CWS and Service 2007) has no delisting criteria, due to the extremely endangered status of the species, but does set forth two primary objectives that will allow the species to be reclassified to threatened (down-listed):

i. Maintain a minimum of 40 productive pairs in the Aransas-Wood Buffalo population for at least 10-years, while managing for the continued increase of the population; and,
ii. Establish a minimum of 25 productive pairs in self-sustaining populations at each of 2 other discrete locations.

A productive pair is defined as a pair that nests regularly and has fledged offspring. The two additional populations may be migratory or non-migratory. All three populations must be self-sustaining for a decade at the designated levels before down-listing could occur. The second objective is to maintain a genetically stable captive population to ensure against extinction of the species by maintaining 153 whooping cranes in captivity (21 productive pairs).

Conservation actions have improved the status of the species. Threats to whooping cranes have been alleviated to a degree sufficient to allow an average annual growth of 4.5 percent for a half century in the Aransas-Wood Buffalo population. For example, power lines are being marked to make them more visible, a technique shown to reduce sandhill crane collisions with power lines (Morkill 1990, Morkill and Anderson 1991, Brown and Drewien 1995), which could also help reduce whooping crane mortality. Additionally, the Cooperative Protection Plans implemented by provincial, State, and Federal agencies are believed to reduce losses to shooting and disease (Lewis 1992); erosion of wintering habitat along the Gulf Intracoastal Water Way has been reduced significantly through the use of concrete matting (Zang *et al.* 1993, Evans and Stehn 1997); and dredged material has been used to create additional wintering habitat (Evans and Stehn 1997).

Based on the 4.5 percent growth rate from 1938-1991, Mirande *et al.* (1993) projected the Aransas-Wood Buffalo population to reach 500 individuals within 17-years, with no measurable probability of extinction over 100-years. Wood Buffalo NP provides suitable protected nesting habitats that have supported population recovery from 3 or 4 adult pairs in 1941 to 75 adult pairs in 2011 (Whooping Crane Conservation Association 2011). Sufficient migratory stopover habitat is available to support the present population and numbers likely to be attained in the near future. Wintering habitats at ANWR are presently sufficient to support at least 500 individuals (Tom Stehn, ANWR, pers. comm.). Currently, 5 captive flocks are producing offspring. Captive production has been sufficient to provide 289 birds for the non-migratory reintroduction experiment in Florida since 1993. In 2001, another reintroduction using captive-produced young was initiated in the eastern U.S with Wisconsin as the proposed nesting area and western Florida the wintering site. Based upon overall habitat availability, a positive growth rate, success in captive breeding, and effective conservation measures, the potential for continued survival of the species and ultimate recovery is good (Service 2007).

Factors affecting the Species within the Action Area

According to our consultations tracking database, there have been no formal consultations authorizing impacts to whooping cranes or their habitat within the action area considered in this consultation. One recent consultation authorized incidental take of up to one Whooping Crane due to existing and proposed construction of new power lines associated with the species' migratory flyway.

Critical habitat

Critical habitat was designated for the Whooping Crane on May 15, 1978 (43 FR 20938) in four States (Nebraska, Kansas, Oklahoma, and Texas). In Texas, this designation includes land, water, and airspace in Aransas, Calhoun, and Refugio Counties within specific boundaries described in the Final Rulemaking (43 FR 20938). This rule-making predates the October 1, 1984, regulation stipulating that primary constituent elements (PCEs) essential for the conservation of the species be identified at the time critical habitat is designated (49 FR 38900).

4. Effects of the Action

This section includes an analysis of the direct and indirect effects of the action of issuing of a section 10(a)(1)(B) permit on the considered species and designated critical habitats.

a. Factors to be considered

Factors to be considered include:

i. The weather-dependent effects of the action;
ii. The probability of drought and a repeat of DOR-like conditions; and,
iii. The potential impacts of climate change.

The weather-dependent effects of the action

The EARIP HCP includes covered activities, minimization and mitigation measures, and activities intended to contribute to the recovery of the species. Implementation of these actions may result in a range of different effects to the species considered in relation to precipitation and recharge conditions throughout the region. The effects of the action, therefore, will be a function of precipitation and recharge conditions experienced over the duration of the 15-year permit. For example, some actions such as CPM pumping restrictions will not affect water levels in the aquifer and therefore will not impact springflows at Comal or San Marcos Springs during periods of normal or above-normal precipitation and recharge. These same measures, however, are expected to affect aquifer levels and springflows during drought conditions that may affect the considered species and their habitats.

Because the effects of the action are weather-dependent, the analysis of stressors, potential exposures, and resulting effects of the various measures are provided for both normal and drought conditions. For the purposes of this analysis, "normal" conditions are presumed to follow the average precipitation and recharge conditions observed over the periods of record for the respective springs. The average resulting springflow over the period of record for Comal Springs (1933 to 2009) is 291 cfs (8.24 cms) (EAA 2010a). Average springflow at San Marcos Springs over the period of record (1957 to 2009) is 175 cfs (4.96 cms) (EAA 2010a). The drought conditions analyzed here consist of a repeat of the recorded precipitation and recharge conditions experienced from 1949 through 1956 DOR during the 15-year duration of the permit. This six-year drought is the longest period of severe drought in the region for which precipitation and corresponding springflow data is available. This is referred to throughout the remainder of the document as "DOR-like conditions".

The probability of drought and the recurrence of DOR-like conditions

The U.S. Congress recognized the challenges associated with forecasting and preparing for drought, and established the National Drought Policy Commission under the National Drought Policy Act of 1998 to ensure collaboration between different government agencies on drought-related issues. The work of the Commission culminated in the National Integrated Drought Information System Act of 2006 (NIDIS Act, Public Law 109-430).

The NIDIS Act defined drought as "a deficiency in precipitation that leads to a deficiency in surface or subsurface water supplies (including rivers, streams, wetlands, ground water, soil moisture, reservoir supplies, lake levels, and snow pack); and that causes or may cause substantial economic or social impacts; or substantial physical damage or injury to individuals, property, or the environment" (NIDIS Act of 2006).

Though droughts are common in the region they are usually short in duration and intensity (Riggio et al. 1987). The most severe drought in the study area since precipitation record keeping began is the 6-year DOR event that occurred from 1951 through 1956 that resulted in the only known cessation of flow at Comal Springs (Longley 1995).

Researchers have attempted to determine precipitation patterns prior to the historic record in order to compare the severity and frequency of the DOR with previous droughts. One researcher found that droughts of various lengths occurred 40 times between the years 1700 and 1979 (Mauldin 2003). Most droughts lasted for less than 1-year, and the average drought lasted for 1.8-years. Of the four droughts that lasted for 3-years or more, three occurred in the 1700s and the fourth was the 6-year-long DOR. Though six droughts were found to be more intense for shorter durations, the DOR was determined to be the most intense long-term drought during the studied period (Mauldin 2003). Other research concluded that the DOR was the most prolonged period of sustained drought for a 347-year study period (Therrell 2000). A recent projection of climate data based on dendrochronology techniques suggests that droughts lasting a decade or longer appear to be randomly distributed in Western and Central Texas throughout the reconstructed period of 1500 through 2008 (Cleaveland et al 2011).

Our ability to forecast droughts, however, is confounded by the influence of multiple independent variables and the stochastic nature of these natural events. Recent attempts to generate regional and statewide patterns describe significant uncertainties when projecting future precipitation due to the influence of these complicated interrelated mechanisms (Jiang and Yang 2012). For the purposes of this analysis, therefore, we presume that a seven-year precipitation pattern mimicking conditions experienced during the DOR will occur at some time during the 15-year duration of the permit.

The potential impacts of climate change

Our analyses include consideration of ongoing and projected changes in climate. The terms "climate" and "climate change" are defined by the Intergovernmental Panel on Climate Change (IPCC). "Climate" refers to the mean and variability of different types of weather conditions over time, with 30-years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2007a). The term "climate change" thus refers to a change in the mean or variability of one or more measures of climate (e.g., temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2007a).

Scientific measurements spanning several decades demonstrate that changes in climate are occurring, and that the rate of change has been faster since the 1950s. Based on extensive analyses of global average surface air temperature, the most widely used measure of change; the IPCC concluded that warming of the global climate system over the past several decades is "unequivocal" (IPCC 2007a). In other words, the IPCC concluded that there is no question that the world's climate system is warming. Examples of other changes include substantial increases in precipitation in some regions of the world and decreases in other regions (for these and additional examples, see IPCC 2007a; Solomon *et al.* 2007). Various environmental changes (e.g., shifts in the ranges of plant and animal species, conditions more favorable to the spread of invasive species and of some diseases, changes in amount and timing of water availability) are occurring in association with changes in climate (see IPCC 2007a, Global Climate Change Impacts in the United States 2009).

Results of scientific analyses presented by the IPCC show that most of the observed increase in global average temperature since the mid-20th century cannot be explained by natural variability in climate, and is "very likely" (defined by the IPCC as 90 percent or higher probability) due to the observed increase in greenhouse gas (GHG) concentrations in the atmosphere as a result of human activities, particularly carbon dioxide emissions from fossil fuel use (IPCC 2007, Solomon *et al.* 2007). Further confirmation of the role of GHGs comes from analyses by Huber and Knutti (2011), who concluded that it is extremely likely that approximately 75 percent of global warming since 1950 has been caused by human activities.

Scientists use a variety of climate models, which include consideration of natural processes and variability, as well as various scenarios of potential levels and timing of GHG emissions, to evaluate the causes of changes already observed and to project future changes in temperature and other climate conditions (e.g., Meehl *et al.* 2007, Ganguly *et al.* 2009, Prinn *et al.* 2011). All combinations of models and emissions scenarios yield very similar projections of average global warming until about 2030. Although projections of the magnitude and rate of warming differ after about 2030, the overall trajectory of all the projections is one of increased global warming through the end of this century, even for projections based on scenarios that assume that GHG emissions will stabilize or decline. Thus, there is strong scientific support for projections that warming will continue through the 21st century, and that the magnitude and rate of change will be influenced substantially by the extent of GHG emissions (IPCC 2007a, Meehl *et al.* 2007, Ganguly *et al.* 2009, Prinn *et al.* 2011).

In addition to basing their projections on scientific analyses, the IPCC reports projections using a framework for treatment of uncertainties (e.g., they define "very likely" to mean greater than 90 percent probability, and "likely" to mean greater than 66 percent probability; see Solomon *et al.* 2007). Some of the IPCC's key projections of global climate and its related effects include: (1) it is virtually certain there will be warmer and more frequent hot days and nights over most of the earth's land areas; (2) it is very likely there will be increased frequency of warm spells and heat waves over most land areas; (3) it is very likely that the frequency of heavy precipitation events, or the proportion of total rainfall from heavy falls, will increase over most areas; and (4) it is likely the area affected by droughts will increase, that intense tropical cyclone activity will increase, and that there will be increased incidence of extreme high sea level (IPCC 2007b). More recently, the IPCC published additional information that provides further insight into observed changes since 1950, as well as projections of extreme climate events at global and broad regional scales for the middle and end of this century (IPCC 2011).

Various changes in climate may have direct or indirect effects on species. These may be positive, neutral, or negative, and they may change over time, depending on the species and other relevant considerations, such as interactions of climate with other variables such as habitat fragmentation (for examples, see Franco *et al.* 2006, IPCC 2007, Forister *et al.* 2010, Galbraith *et al.* 2010, Chen *et al.* 2011). In addition to considering individual species, scientists are evaluating possible climate change–related impacts to, and responses of, ecological systems, habitat conditions, and groups of species; these studies include acknowledgement of uncertainty (e.g., Deutsch *et al.* 2008, Berg *et al.* 2009, Euskirchen *et al.* 2009, McKechnie and Wolf 2009, Sinervo *et al.* 2010, Beaumont *et al.* 2011, McKelvey *et al.* 2011, Rogers and Schindler 2011).

Many analyses involve elements that are common to climate change vulnerability assessments. In relation to climate change, vulnerability refers to the degree to which a species (or system) is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the type, magnitude, and rate of climate change and variation to which a species is exposed, its sensitivity, and its adaptive capacity (IPCC 2007a, Glick *et al.* 2011). There is no single method for conducting such analyses that applies to all situations (Glick *et al.* 2011). We use our expert judgment and appropriate analytical approaches to weigh relevant information, including uncertainty, in our consideration of various aspects of climate change.

Global climate projections are informative, and, in some cases, the only or the best scientific information available for us to use. However, projected changes in climate and related impacts can vary substantially across and within different regions of the world (IPCC 2007a). Therefore, we use "downscaled" projections when they are available and have been developed through appropriate scientific procedures, because such projections provide higher resolution information that is more relevant to spatial scales used for analyses of a given species (Glick *et al.* 2011).

Localized projections suggest the southwestern United States may experience the greatest temperature increase of any area in the lower 48 States (IPCC 2007a), with warming increases in southwestern States greatest in the summer. The IPCC also predicts hot extremes, heat waves, and heavy precipitation will increase in frequency (IPCC 2007a).

The degree to which climate change will affect the species or habitats considered here is uncertain. Climate change will be a particular challenge for biodiversity in general because the interaction of additional stressors associated with climate change and current stressors may push species beyond their ability to survive (Lovejoy 2005). The synergistic implications of climate change and habitat fragmentation are the most threatening facets of climate change for biodiversity (Hannah and Lovejoy 2005). Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field *et al.* 1999, Hayhoe *et al.* 2004, Cayan *et al.* 2005, IPCC 2007a). Climate change may lead to increased frequency and duration of severe storms and droughts (McLaughlin *et al.* 2002, Cook *et al.* 2004, Golladay *et al.* 2004).

An increased risk of drought could occur if evaporation exceeds precipitation levels in a particular region due to increased greenhouse gases in the atmosphere (CH2M HILL 2007). The Edwards Aquifer is also predicted to experience additional stress from climate change that could lead to decreased recharge and low or ceased spring flows given increasing pumping demands (Loaiciga *et al.* 2000). A reduction of recharge to aquifers and a greater likelihood for more extreme droughts were identified as potential impacts to water resources (CH2M HILL 2007).

The droughts of 2008–2009 and 2010–2011 were two of the worst short-term droughts in central Texas history, with the period from October 2010 through September 2011 being the driest 12-month period in Texas since rainfall records began (Lower Colorado River Authority (LCRA) 2011). As a result, the effects of climate change could compound the threat of decreased water quantity due to drought.

b. Analysis for effects of the Action

The amounts of incidental take provided below are estimates because the actual amounts will be a function of the occurrence, intensity, and severity of precipitation and drought conditions that occur over the 15-year duration of the permit. Estimates of incidental take anticipated to occur during average and above average precipitation and recharge conditions are provided for the effects of the action. For the purposes of this analysis, the recurrence of precipitation and recharge conditions similar to the drought of record are presumed to occur once during the duration of the permit, thus yielding impacts considered maximum values.

Quantifying the impacts to and take of individuals is difficult due to the aquatic and subterranean nature of many of the species considered here. Effects of the action that might include reduction in springflow, for example, are likely to result in harm or harassment through displacement rather than in injury or death of individuals. Actual numbers of individuals that may be injured or killed may not be known because in some cases we lack the ability to effectively survey the subterranean aquatic habitats some of these species occupy, and the small size of some species and the soft and quickly decomposed bodies of others make detection of injured or dead individuals in aquatic environments uncertain. This biological opinion therefore evaluates the quantity of habitat affected as a surrogate for the level of incidental take or impacts in some cases. For the species considered here, most incidental take, or impacts, from covered activities are expected to occur in the form of harm and harassment through direct loss of habitat and indirect adverse effects resulting from the issuance of an incidental take permit under Section 10(a)(1)(B) of the Act.

A number of measures described in the EARIP HCP are intended to enhance or restore habitats or to increase the distribution and abundance of the covered species in an effort to increase the viability and resilience of these populations or the capacity of their habitats to provide elements important for breeding, feeding, or sheltering in the face of current and potential threats. Implementing these measures, however, may result in some effects to the species. The short-term impacts of implementation and the anticipated results of these restoration and enhancement measures are described for each species and their respective habitats below.

All of the species and designated critical habitats considered here are affected by the quantity and quality of water within or flowing from the springs of the Edwards Aquifer. The effects of the action on water quantity and quality are described in a general manner here, with species and critical habitat-specific effects described below.

The EARIP Applicants have committed to achieve the aquifer-level and springflow-dependent biological goals and objectives described in their HCP. The measures implemented to achieve these goals will be monitored and adjusted over time through the adaptive management program that is an integral part of the conservation plan. The analysis provided here is based upon implementation of the measures as described to achieve goals and objectives established by the Applicants.

The effects of the action include the results of implementing flow protection and springflow management measures including changes to EAA CPM pumping restrictions, the management and use of the SAWS ASR to support springflows, implementation of the VISPO program or equivalent necessary measures, and reductions of surface water diversions from Spring Lake and the San Marcos River.

The effects of regulation and production of groundwater and implementing these flow protection and springflow management measures will not affect aquifer levels resulting springflows at Comal Springs or San Marcos Springs, or the resulting instream flows in the Comal and San Marcos Rivers during periods of average precipitation and recharge. The flow protection and springflow management measures will generate changes in aquifer levels resulting in increased springflows and instream flows during drought conditions that may affect these species.

The magnitude of the CPM pumping restrictions is directly related to precipitation and recharge as measured at the J-17 Bexar County and J-27 Uvalde County index wells for the San Antonio and Uvalde Pools, respectively. The environmental baselines for these species account for the effects of EAA CPM pumping restrictions Stages I through IV because these measures are currently in place (see Section 3, Status of the Species and Environmental Baseline, above). The effects of the action include the addition of Stage V to the existing CPM plan. During Phase I of HCP implementation, Stage V triggers pumping cutbacks of 44% in the San Antonio Pool when any one of three thresholds is met:

i. Monthly J-17 index well levels average 625 feet (190.5 meters) above msl; or,
ii. The ten-day rolling average springflow at Comal Springs falls to 45 cfs (1.27 cms) or lower; or,
iii. The three day rolling average springflow at Comal Springs drops to 40 cfs (1.13 cms) or lower.

Phase I Stage V pumping cutbacks of 44% are triggered in the Uvalde Pool when the water level in the J-27 index well falls to 840 feet (256 meters) above msl. During Phase II of HCP implementation, Stage V pumping cutbacks increase from 44% to 47% in both the San Antonio and Uvalde Pools. The CPM pumping restrictions maintain higher aquifer levels that generate increased springflows at Comal Springs and San Marcos Springs when compared to the four-Stage CPM restrictions currently in place. These increased springflows maintain flows within Landa Lake and Spring Lake and resulting instream flows in the Comal and San Marcos Rivers. The effects of the action resulting from indirect effects of changes to EAA's CPM pumping restrictions, therefore, include increased aquifer levels, springflows, and instream flows that reduce the considered species' exposure to lowered aquifer levels and reduced flows during drought conditions.

The SAWS ASR is an underground reservoir in which Edwards Aquifer water is stored when water supplies exceed demand. Stored water is pumped from this facility to meet SAWS customer needs when demand is high. Under the HCP, up to 50,000 acre feet (61,674,450 cubic meters) of Edwards Aquifer water will be stored in the ASR facility to support springflows during critical drought periods. When J-17 index well levels drop to 630 feet (192 meters) above msl during critical drought periods (defined by a rolling 10-year Edwards Aquifer recharge average of 500,000 acre feet [616,744,500 cubic meters] or less) SAWS will reduce pumping from Edwards Aquifer wells in the northeast portion of their water distribution system by up to approximately 184 acre feet (226,962 cubic meters) of water per day. This will be offset by pumping stored water from the ASR to SAWS customers to meet water demand. Pumping water from the aquifer near the springs has a more immediate impact on springflows than equivalent amounts of pumping farther from the springs. Reducing up to 50,000 acre feet (61,674,450 cubic meters) of Edwards Aquifer pumping relatively close to the springs during drought conditions, therefore, will maintain elevated aquifer levels and increased Comal and San Marcos springflows over those currently expected and accounted for in the environmental baseline for the species described above.

One of the conservation plan measures is the implementation of the Voluntary Irrigation Suspension Program (VISPO). This measure will contribute to increased aquifer levels and resulting springflows by suspending the use of Aquifer water for irrigation purposes during drought conditions. Participating irrigators are provided an economic incentive in the form of an annual payment for every acre foot of water enrolled in the program regardless of precipitation or aquifer levels, with increased amounts paid for longer enrollment commitments. Suspension of pumping will be triggered if the Bexar County J-17 Index well falls to 635 feet (193.5 meters) above msl or lower on October 1 each year, and will require participating irrigators to cease pumping the enrolled volume of water for the following year beginning January 1. Participants will be paid an additional amount when pumping is suspended indexed to the term of their commitment for each acre foot of water enrolled. The Applicants believe, based on the development of this program in close coordination with the agricultural community, the interest in the VISPO expressed by prospective participants during multiple meetings, and written expressions of interest from irrigators, that 40,000 acre feet (49,339,274 cubic meters) of water will be enrolled in the program over the 15-year duration of the permit.

Though the voluntary nature of this program may call into question the reasonable certainty with which this volume of water will be enrolled in the program, the Applicants have committed to achieve the springflows anticipated to result from the targeted 40,000 acre foot (49,339,274 cubic meter) commitment though other means, including additional region-wide pumping cuts, if necessary. The certainty that this volume of pumping cutbacks will be achieved during the described drought conditions, therefore, is assured by the commitments of the Applicants to this goal by other means as necessary (See EARIP HCP Section 5.1.2.4). The reduction of 40,000 acre feet (49,339,274 cubic meters) of Edwards Aquifer pumping during drought conditions will therefore maintain elevated aquifer levels and resulting increased springflows over those currently expected and accounted for in the environmental baselines above.

Texas State University holds the right to divert 8.1 cfs (0.23 cms) from surface waters for consumptive use under TCEQ Certificates 18-3865 and 18-3866. Surface water diversion reduction commitments in the HCP will increase flows in the San Marcos and Spring Lake system during drought conditions. HCP implementation will trigger Texas State University's commitment to reduce the diversion of surface water from Spring Lake and the San Marcos River to which they are otherwise entitled in response to flow rates recorded at the U.S. Geological Survey (USGS) stream gauge located at University Bridge (USGS Gauge 08170500).

When streamflow reaches 80 cfs (2.27 cms), the University will reduce surface water diversions by 2 cfs (0.06 cms). The University will reduce diversions by an additional 2 cfs (0.06 cms) when streamflow reaches 60 cfs (1.7 cms) and by another 1 cfs (0.03 cms) when streamflow reaches 49 cfs (1.4 cms). The University will suspend all diversion of surface water if streamflow falls to 45 cfs (1.3 cms) (See HCP Section 5.4.5). These reductions in surface water diversion will allow these water volumes to remain in Spring Lake and the San Marcos River, and result in increased flows over levels expected in the environmental baseline during drought conditions.

The combined effect of these actions during periods of drought will maintain increased water levels within the aquifer and provide for greater springflows at Comal and San Marcos Springs and resulting instream flows in the Comal and San Marcos Rivers than would be expected under equivalent precipitation and recharge conditions today. These increased flows will reduce the threat posed by loss of water within the aquifer or flowing from Comal and San Marcos Springs during drought conditions. A description of how these measures will affect each considered species is provided below.

The EARIP HCP includes implementation of a Regional Water Conservation (RWC) Program that will generate an initial annual reduction of 10,000 acre feet (12,334,819 cubic meters) of pumping from the aquifer upon permit issuance, with a commitment by the Applicants to achieve 20,000 acre feet (24,669,637 cubic meters) of reduced demand over the duration of the permit. This measure will build upon successful existing programs and expertise by expanding water conservation efforts throughout the region (see HCP Section 5.1.3 for program details). The initial annual reduction of 10,000 acre feet (12,334,819 cubic meters) of pumping from current permitted amounts is triggered upon permit issuance, thereby increasing aquifer levels and resulting springflows irrespective of precipitation and recharge conditions. The effects of the action include the increased aquifer levels generated by this measure and the resulting increased springflows that decrease potential exposure of the considered species to reduced aquifer levels and resulting springflows under drought conditions.

The combined effects of the flow protection, springflow management measures, and the RCW Program described above during a repeat of DOR-like conditions generate a continuous minimum total springflow of 27 cfs (0.75 cms) during HCP Phase I and 30 cfs (0.85 cms) during Phase II at Comal Springs. These are comparable to the cessation of flow for four-months reported in 1956, and projected cessation for 38-months or 36-months under today's maximum allowable pumping and recent average (2000 through 2010) pumping projections, respectively as described in the environmental baseline above. The effect of the action at Comal Springs, therefore, results in continual minimum springflows that exceed both historic and projected current flow rates under DOR-like conditions. Figure 2 (above) illustrates the reported historic springflows and compares the effects of the baseline ("No Action") and the HCP (Alternatives 2a and 2b) action at Comal Springs.

The combined effects of the flow protection, springflow management, and the RCW Program described above during a repeat of DOR-like conditions result in a continuous minimum total springflow of 50.5 cfs (1.43 cms) during HCP Phase I and 51.2 cfs (1.45 cms) during Phase II at San Marcos Springs. These are comparable to the historical flow of 54 cfs (1.53 cms) reported in 1956, and a projected cessation of flow under current conditions during both maximum permitted pumping and recent average (2000 through 2010) pumping described in the environmental baseline above. The effect of the action at San Marcos Springs, therefore, results in continual minimum springflows that exceed both historic and projected current flow rates under DOR-like conditions. Figure 1 (above) illustrates the reported historic springflows and compares the effects of the baseline ("No Action") and the HCP (Alternatives 2a and 2b) action at San Marcos Springs.

The EARIP HCP a measure that limits hazardous materials transport across the Comal and San Marcos Rivers and their tributaries to reduce the probability of a spill or other release that could impact covered species (See HCP Sections 5.3.4). The City of San Marcos has committed to implement a household hazardous waste program, a septic system registration and permitting program, impervious cover and water quality protection efforts, and contaminated runoff and stormwater minimization efforts to reduce ground water and surface water contamination (See HCP Sections 5.7.3 through 5.7.6). The effects of the action include implementation of these measures and the resulting reduction of threats to water quality regardless of precipitation and recharge conditions.

To estimate the effects of incidental take that may result as an effect of the action, we assume that eight-years of average precipitation and recharge conditions and a repeat of the seven-year DOR-like event will occur over the duration of the proposed permit. We derived the projected impact of the effects of the action under average conditions and multiplied by a factor of eight to estimate the total impacts over the duration of the permit. We believe this approach results in projections that are conservative of the species considered here because the analysis presumes that adverse impacts associated with these measures are continual and recur on an annual basis. Actual impacts from many of these events are anticipated to occur irregularly or only once during the duration of the permit (such as removal of sand bars with the Comal and San Marcos Rivers or replacement of water diversion infrastructure in the old and new channels of the Comal River). We also generated expected impacts of a DOR-like event, and added these effects to those expected under average conditions. The beneficial effects resulting from these measures (such as improved habitat suitability that enhances feeding or sheltering, or reduced competition and predation) are not accounted for in this analysis. The projected impacts, therefore, represents maximum adverse impacts without accounting for the expected beneficial effects of these measures.

i. Texas wild-rice

Effects of the action on Texas wild-rice

Implementation of flow protection and springflow management measures that affect Texas wild-rice include: changes to EAA CPM pumping restrictions, the management and use of the SAWS ASR to support springflows, implementation of the VISPO program or equivalent necessary measures, and reductions of surface water diversions from Spring Lake and the San Marcos River. During periods of average precipitation and recharge the effects of regulation and production of groundwater and implementing these flow protection and springflow management measures will not affect aquifer levels impacting springflows at San Marcos Springs and the San Marcos River.

The Recovery Plan for Texas wild-rice states that reduced springflow is the greatest threat to the species (Service 1996a). Texas wild-rice is intolerant of desiccation, and recent drought events that dewatered portions of the river resulted in the death of stands of the species. Under projected maximum pumping permitted and recent average pumping totals described in the environmental baseline above, San Marcos Springs are anticipated to cease flowing during a repeat of DOR-like conditions. The resulting cessation of flow in the San Marcos River would likely result in the loss of most Texas wild-rice stands in the San Marcos River. Stands located in Spring Lake or in deeper stretches of the San Marcos River might survive these conditions for an undetermined period of time, but the loss of required dissolved carbon dioxide associated with flowing Edwards Aquifer spring water could adversely affect the species.

The combined effect of the flow protection and springflow management measures during periods of drought and the increased aquifer levels generated by the RWC Program (described above) will maintain increased water levels within the aquifer and provide for greater flow at San Marcos Springs and the San Marcos River than would be expected under equivalent conditions today. The effects of the action, therefore, will decrease the exposure of Texas wild-rice to reduced springflow during drought conditions.

Texas wild-rice requires clean water, and pollution is cited as a threat to the species (Service 1996a). The effects of the action include the measures described above that reduce the potential for groundwater or surface water contamination. These measures will reduce these threats regardless of precipitation and recharge conditions. An indirect effect will be a resulting decrease in the species' potential exposure to contaminants when compared to baseline conditions.

The HCP established a goal of maintaining no less than 38,200 square feet (3,549 square meters) of Texas wild-rice in Spring Lake and the San Marcos River during a repeat of DOR-like conditions. The most recent range-wide estimate reported approximately 39,400 square feet (3,660 square meters) of Texas wild-rice coverage in the upper San Marcos River and Spring Lake (BIO-WEST 2012). Though the total minimum coverage which the Applicants have committed to maintain represents a decline from the most recent survey results, the coverage of Texas wild-rice during DOR-like conditions today would reflect the cessation of flow described in the environmental baseline and the likely loss of the species from most of the San Marcos River (as described above).

The HCP set a biological goal of establishing and maintaining approximately 86,100 to 166,300 square feet (8,000 to 15,450 square meters) of Texas wild-rice coverage distributed in specific sections of Spring Lake and the upper San Marcos River (see HCP Section 4.1.1.2). Implementation of the enhancement and restoration measures intended to achieve this goal may affect Texas wild-rice. These measures are intended to restore potential habitat, enhance existing populations, reestablish the species in suitable habitat areas not currently occupied, and reduce impacts from non-native species.

To achieve targeted population enhancement and reestablishment goals, habitat restoration activities include targeted removal of non-native aquatic vegetation in areas within existing patches of Texas wild-rice, and removal and replacement of non-native vegetation with stands of Texas wild-rice. Non-native aquatic vegetation in the San Marcos River system can displace

Texas wild-rice by competing for space, light, and nutrients. Stressors associated with restoration program elements include substrate disturbance, increased turbidity, and physical disturbance of Texas wild-rice plants. Individual plants or stands of Texas wild-rice will be exposed to these stressors when in close proximity to restoration activities or in the downstream flow path of plumes of turbidity resulting from these actions. These potential changes to water quality and disturbances to natural substrates are expected to occur while the restoration and enhancement activities are being implemented, and exposure to these stressors is therefore anticipated to be short in duration for any individual Texas wild-rice plant or stand. The effects of the action, therefore, include short duration exposure to degraded water quality and substrate disturbance experienced by individual plants or stands of the species; and reduced competition with non-native vegetation.

The HCP will reduce the introduction and control populations of non-native species to reduce threats including herbivory and habitat disturbance. Some non-native aquatic species in Spring Lake and the San Marcos River are the result of "aquarium dumps", in which pet owners release the unwanted contents of fish tanks directly into rivers and lakes. This is the likely source of species common in the aquarium pet trade now found in the San Marcos River system such as the giant ramshorn snail native to South America and armored suckermouth catfishes native to Central and South America. Giant ramshorn snails are known to feed on Texas wild-rice plants, and armored suckermouth catfishes disrupt substrates and can burrow into and destabilize riverbanks, thereby increasing turbidity and introducing additional sediment loads into the river system. Nutria are semi-aquatic burrowing rodents native to South America now found in the San Marcos River system, that are known to feed on Texas wild-rice and burrow into riverbanks thus increasing turbidity and sedimentation. The effects of the action include reducing the incidence of new introductions and controlling populations of non-native species is expected to reduce Texas wild-rice exposure to the associated stressors and minimize the effects of these threats.

Sediment and Sessom's Creek sand bar removal activities may also affect the species. These actions will reduce threats posed by loss of suitable habitat resulting from sedimentation and impacts to natural substrates in the San Marcos River. Stressors associated with these measures include substrate disturbance, increased turbidity, and physical disturbance of Texas wild-rice plants. Individual plants or stands of Texas wild-rice would be exposed to these stressors when in close proximity to these activities or in the downstream flow path of plumes of turbidity resulting from these actions. These potential changes to water quality and disturbances to natural substrates are expected to occur while these measures are being implemented, and exposure to these stressors is therefore anticipated to be short in duration for any individual Texas wild-rice plant or stand. The effects of the action, therefore, include short duration exposure to degraded water quality and substrate disturbance experienced by individual plants or stands of the species, and reduced exposure to sedimentation and impacts to natural substrates when compared to baseline conditions.

Effects of the action include implementation of management measures addressing water-based recreation associated with Spring Lake and the San Marcos River. These measures will increase public awareness of the species, reduce the effects of bankside erosion, and reduce impacts associated with direct contact with Texas wild-rice. Permanent access points with educational signage and kiosks will reduce the creation and use of unauthorized trails and access areas that erode river banks, contribute sediment loads and generate turbidity. These measures will further reduce the species' exposure to stressors associated with impacts to natural substrates and water quality.

Recreation management will address threats associated with physical contact with Texas wild-rice. Contact is a stressor that can result in physical damage to Texas wild-rice, such as when people floating the river in tubes grasp the long strap-like leaves in the current and break off leaves or uproot the plants; or when floating aquatic vegetation or litter physically prevents flowering stalks from emerging from the water's surface. These activities have been described as affecting Texas wild-rice's ability to successfully reproduce and set seed. The effects of the action resulting in recreation management, and aquatic vegetation and litter control results in reduced exposure to these stressors and minimized effects of physical contact.

Aquatic vegetation and litter management below Sewell Park may also reduce the effects of shading on Texas wild-rice. Shading can reduce the plants' capacity to photosynthesize, and has been suggested as a possible stressor. Reducing floating vegetation and litter may therefore reduce the species' exposure to the effects of shading from these sources when compared to baseline conditions in the river.

The combined effects of these measures during both average and DOR-like conditions, therefore, are not expected to appreciably reduce the survival and recovery of Texas wild-rice in the wild.

Effects of the action on designated critical habitat

Designated critical habitat for Texas wild-rice in Spring Lake and the San Marcos River downstream to its confluence with the Blanco River must provide flowing water of appropriate quality, undisturbed habitats and natural substrates, and minimal physical disturbance to individual plants.

The action will result in implementation of the flow protection and springflow management measures described above. During periods of average precipitation and recharge the regulation and production of groundwater and implementation of these flow protection and springflow management measures will not affect aquifer levels impacting springflows at San Marcos Springs and the San Marcos River. The resulting effects of the action to designated critical habitat for Texas wild-rice during average precipitation and recharge conditions are therefore discountable. During drought conditions the combined effects of these measures will maintain springflows at San Marcos Springs, thereby supporting the capacity of the designated critical habitat to provide flowing water.

The effects of the action that reduce the probability of a spill or other release into the San Marcos River and its tributaries, and that reduce potential contamination of groundwater and surface water also supports the ability of the designated critical habitat to continue to provide appropriate water quality.

The effects of the action will result in implementation of HCP measures that will generate indirect adverse water quality impacts, such as turbidity associated with habitat restoration measures, targeted removal of non-native vegetation, sediment removal, and Sessom's Creek sandbar removal measures. In each case, however, these effects are anticipated to be of short duration, and will not destroy or adversely modify the ability of designated critical habitat to provide appropriate water quality.

Various HCP measures will also result in some disturbance of habitats, natural substrates, and Texas wild-rice plants. These measures include habitat restoration measures, targeted removal of non-native vegetation, sediment removal, Sessom's Creek sandbar removal, and population enhancement and reestablishment measures. These actions may result in short-term adverse effects that generate long-term benefits to the species and its habitat, and will not destroy or adversely modify the habitats or natural substrates required for the conservation of Texas wild-rice.

ii. Golden orb

Effects of the action on the golden orb

The Applicants did not choose to include this candidate species in the list of covered species for which they sought incidental take protection, and no such authorization is provided in the action.

Implementation of flow protection and springflow management measures that affect the golden orb include changes to EAA CPM pumping restrictions, the management and use of the SAWS ASR to support springflows, implementation of the VISPO program or equivalent necessary measures, and reductions of surface water diversions from Spring Lake and the San Marcos River. During periods of average precipitation and recharge the indirect effects of regulation and production of groundwater in accordance with State law and implementing these flow protection and springflow management measures will not affect aquifer levels impacting springflows and resulting instream flows in the Comal and San Marcos Rivers.

The combined effect of the flow protection and springflow management measures during periods of drought and the increased aquifer levels generated by the RWC Program (described above) will maintain increased water levels within the aquifer and provide for greater instream flow in the Comal and San Marcos Rivers than would be expected under equivalent conditions today. Because both the Comal and San Marcos Rivers contribute streamflow to the Guadalupe River, this system will also experience resulting increased flows as a result of the action during drought conditions.

Dewatering has been has been cited as a threat to the golden orb (76 FR 62166). Under projected maximum pumping permitted and recent average pumping totals described in the environmental baseline above, Comal and San Marcos Springs are anticipated to cease flowing during a repeat of DOR-like conditions. The effects of the action will reduce this threat for populations in the lower San Marcos and middle Guadalupe Rivers over the existing baseline condition. The action may also help alleviate this threat for golden orbs in the lower Guadalupe River by increasing instream flows over current baseline conditions.

Decreased water quality and chemical contamination have been cited as threats to the golden orb (76 FR 62166). The effects of the action include the measures described above that reduce the potential for groundwater or surface water contamination. These measures will reduce these threats regardless of precipitation and recharge conditions. An indirect effect will be a resulting decrease in the species' potential exposure to contaminants when compared to baseline conditions.

Sediment removal activities may generate turbidity that can be a stressor for the golden orb. These actions will reduce the threats posed by sedimentation and impacts to natural substrates in the San Marcos River. Implementation of these activities is likely to generate sediment disturbance and turbidity while reducing total sediment loads in the river. Individuals likely to be impacted by these activities would be close to substrate disturbances or in the downstream flow path of turbidity plumes associated with these actions. These impacts could result in harassment of the golden orb or harm to the species' habitat. Because golden orbs within the action area are now known from only the lower San Marcos and the middle and lower Guadalupe Rivers, individuals of the species are unlikely to be directly affected by these actions occurring in Spring Lake and the upper San Marcos River. The activities that generate these stressors are anticipated to reduce total sediment loads in the San Marcos and Guadalupe Rivers. The effects of the action include short-term changes to water quality and natural substrates while these actions are implemented and an overall reduction in exposure to sedimentation and impacts to natural substrates over baseline conditions.

Effects of the action on designated critical habitat

The golden orb is currently a candidate for listing as threatened or endangered, therefore no critical habitat has been designated for this species and none will be affected by the action.

iii. Texas pimpleback

Effects of the action on the Texas pimpleback

The Applicants did not choose to include this candidate species in the list of species for which they sought incidental take protection, and no such authorization is provided in the action.

Implementation of flow protection and springflow management measures that affect the Texas pimpleback include changes to EAA CPM pumping restrictions, the management and use of the SAWS ASR to support springflows, implementation of the VISPO program or equivalent necessary measures, and reductions of surface water diversions from Spring Lake and the San Marcos River. During periods of average precipitation and recharge the indirect effects of regulation and production of groundwater in accordance with State law and implementing these flow protection and springflow management measures will not affect aquifer levels impacting springflows and resulting instream flows in the Comal and San Marcos Rivers.

The combined effect of the flow protection and springflow management measures during periods of drought and the increased aquifer levels generated by the RWC Program will maintain increased water levels within the aquifer and provide for greater instream flow in the Comal and San Marcos Rivers than would be expected under equivalent conditions today. Because both the Comal and San Marcos Rivers contribute streamflow to the Guadalupe River, this system will also experience resulting increased flows as a result of the action during drought conditions.

Dewatering has been has been cited as a threat to the Texas pimpleback (76 FR 62166). Under projected maximum pumping permitted and recent average pumping totals described in the environmental baseline above, Comal and San Marcos Springs are anticipated to cease flowing during a repeat of DOR-like conditions. The effects of the action will reduce this threat for populations in the San Marcos and Guadalupe Rivers over the existing baseline condition. Decreased water quality and chemical contamination have been cited as threats to the Texas pimpleback (76 FR 62166). The effects of the action include the measures described above that reduce the potential for groundwater or surface water contamination. These measures will reduce these threats regardless of precipitation and recharge conditions. An indirect effect will be a resulting decrease in the species' potential exposure to contaminants when compared to baseline conditions.

Sediment removal activities may generate turbidity that can be a stressor for the Texas pimpleback. These actions are proposed to reduce the threats posed by sedimentation and impacts to natural substrates in the San Marcos River. Implementation of these activities is likely to generate sediment disturbance and turbidity while reducing total sediment loads in the river. Individuals likely to be impacted by these activities would be close to substrate disturbances or in the downstream flow path of turbidity plumes associated with these actions. These impacts could result in harm or harassment to Texas pimpleback mussels. The very few individuals remaining in the San Marcos and Guadalupe Rivers are unlikely to be directly affected by these actions occurring in Spring Lake and the upper San Marcos River. The activities that generate these stressors are anticipated to reduce total sediment loads in the San Marcos and Guadalupe Rivers. The effects of the action include short-term changes to water quality and natural substrates while these actions are implemented and an overall reduction in exposure to sedimentation and impacts to natural substrates over baseline conditions.

Effects of the action on designated critical habitat

Because the Texas pimpleback is currently a candidate for listing as threatened or endangered, there is no designated critical habitat for this species and none will be affected by the action.

iv. Texas fatmucket

Effects of the action on the Texas Fatmucket

The Applicants did not choose to include this candidate species in the list of species for which they sought incidental take protection, and no such authorization is provided in the action.

Implementation of flow protection and springflow management measures that affect the Texas fatmucket include changes to EAA CPM pumping restrictions, the management and use of the SAWS ASR to support springflows, implementation of the VISPO program or equivalent necessary measures, and reductions of surface water diversions from Spring Lake and the San Marcos River. During periods of average precipitation and recharge the indirect effects of regulation and production of groundwater in accordance with State law and implementing these flow protection and springflow management measures will not affect aquifer levels impacting springflows and resulting instream flows in the Comal and San Marcos Rivers.

The combined effect of the flow protection and springflow management measures during periods of drought and the increased aquifer levels generated by the RWC Program will maintain increased water levels within the aquifer and provide for greater instream flow in the Comal and San Marcos Rivers than would be expected under equivalent conditions today. Because both the Comal and San Marcos Rivers contribute streamflow to the Guadalupe River, this system will also experience resulting increased flows as a result of the action during drought conditions.

Dewatering has been has been cited as a threat to the Texas fatmucket (76 FR 62166). Under projected maximum pumping permitted and recent average pumping totals described in the environmental baseline above, Comal and San Marcos Springs are anticipated to cease flowing during a repeat of DOR-like conditions. The effects of the action will reduce this threat for remaining individuals in the Guadalupe River over the existing baseline condition.

Decreased water quality and chemical contamination have been cited as threats to the Texas fatmucket (76 FR 62166). The effects of the action include the measures described above that reduce the potential for groundwater or surface water contamination. These measures will reduce these threats regardless of precipitation and recharge conditions. An indirect effect will be a resulting decrease in the species' potential exposure to contaminants when compared to baseline conditions.

Sediment removal activities may generate turbidity that can be a stressor for the Texas fatmucket. These actions are proposed to reduce the threats posed by sedimentation and impacts to natural substrates in the San Marcos River. Implementation of these activities is likely to generate sediment disturbance and turbidity while reducing total sediment loads in the river. Individuals likely to be impacted by these activities would be close to substrate disturbances or in the downstream flow path of turbidity plumes associated with these actions. These impacts could result in harm or harassment to Texas fatmucket mussels. The remaining individuals in the Guadalupe River are unlikely to be directly affected by these actions occurring in Spring Lake and the upper San Marcos River. The activities that generate these stressors are anticipated to reduce total sediment loads in the San Marcos and Guadalupe Rivers. The effects of the action include short-term changes to water quality and natural substrates while these actions are implemented and an overall reduction in exposure to sedimentation and impacts to natural substrates over baseline conditions.

Effects of the action on designated critical habitat

Because the Texas fatmucket is currently a candidate for listing as threatened or endangered, there is no designated critical habitat for this species and none will be affected by the action.

v. Comal Springs dryopid beetle

Effects of the action on the Comal Springs dryopid beetle

Implementation of flow protection and springflow management measures that affect the Comal Springs dryopid beetle include changes to EAA CPM pumping restrictions, the management and use of the SAWS ASR to support springflows, and implementation of the VISPO program or equivalent necessary measures. During periods of average precipitation and recharge, the effects of regulation and production of groundwater in accordance with State law and implementing these flow protection and springflow management measures will not affect aquifer levels impacting springflows at Comal Springs.

Reduction or loss of water has been described as one of the main threats to the Comal Springs dryopid beetle, and ensuring increased flows during periods of drought may reduce the species' exposure to this effect. During drought conditions, the combined effect of the flow protection and springflow management measures and the increased aquifer levels generated by the RWC Program (described above) will maintain increased water levels within the aquifer and provide for greater springflows at Comal Springs than would be expected under equivalent conditions today.

The Comal Springs dryopid beetle's specialized subterranean and aquatic adaptations limit the species' ability to utilize new habitats or expand its range. The aquatic species cannot swim or fly, and it has been suggested that they may be confined to small areas surrounding spring openings. The extent of the subterranean range of the species is unknown, though to date it is only known from natural spring openings at Comal Springs and Fern Bank Springs and from Panther Canyon well. These limitations to movement support suggestions that the species survived the DOR event by utilizing subterranean components of the aquifer and springs systems.

The various spring outlets in the Comal Springs system are located at different elevations above sea level. As aquifer levels fluctuate, therefore, springflows at each outlet reflect their relative elevation. At aquifer levels of approximately 622 feet (189.5 meters) above msl, Comal Spring Runs # 1 and # 2 cease to flow. This aquifer level corresponds with Comal springflows of approximately 130 cfs (3.7 cms). Spring Run # 3 ceases flowing at aquifer levels of about 620 feet (189 meters) above msl, which corresponds to Comal Springs flows of approximately 50 cfs (1.4 cms). Under the baseline conditions, a repeat of DOR-like conditions would result in the projected cessation of flow at Comal Springs for 38-months or 36-months under today's maximum allowable pumping and recent average (2000 through 2010) pumping projections, respectively.

Under a repeat of DOR-like conditions with implementation of the HCP, flows in Comal Springs maintain 27 cfs (0.76 cms) during HCP Phase I and 30 cfs (0.85 cms) during Phase II at Comal Springs for short periods. The effect of the action at Comal Springs, therefore, results in springflows that exceed both historic and projected current flow rates under DOR-like conditions. Figure 2 (above) illustrates the reported historic springflows and compares the effects of the baseline ("No Action") to HCP implementation (Alternatives 2a and 2b) at Comal Springs.

Though these flows will result in cessation of flow at Comal Spring Runs # 1, # 2, and # 3; water levels within Panther Canyon well and seeps along the western shoreline of Landa Lake and within upwellings near Spring Island are expected to continue to provide available habitat for the species. Comal Springs dryopid beetles within spring Runs # 1, # 2, and # 3 may be able to utilize the subterranean portions of the aquifer and the springs during these conditions, though they will be displaced by the reduced springflows and may be injured or killed during these conditions.

The hydrology supporting Fern Bank Springs is not sufficiently understood to predict how these actions may impact flows at this location. Fern Bank Springs may be partially sourced from the Southern Segment of the Edwards Aquifer, or springflows at this location may completely arise from other sources. Though this spring system has been described as never ceasing to flow, there is no data available to either support or refute that claim. The effect of the action, however, is expected to generate increases in aquifer levels that may provide some support of springflows at Fern Bank Springs during drought conditions if these systems are hydrologically linked.

The effect of the action includes implementation of measures to protect and enhance water quality (as described above) that will decrease potential groundwater and surface water contamination and reduce threats to the species from exposure to these stressors over conditions found today. The effects of the action, therefore, will reduce the threat of water contamination and reduce the potential for the species to be exposed to these threats.

Restoration of riparian zones including the removal of non-native vegetation and restoration of native woody species are planned minimization and mitigation measures in the HCP. The Comal Springs dryopid beetle may be affected by these activities. Likely stressors associated with riparian zone restoration elements include substrate disturbance and increased turbidity. These impacts could result in harm or harassment resulting from displacement or injury. Comal Springs dryopid beetles could be exposed to these stressors when in close proximity to restoration activities. The effects of the action include short term water quality effects and potential displacement or injury anticipated to occur while these activities are implemented. The effects of the action also include the reestablishment of native woody vegetation that supports the feeding needs of the species when compared to existing baseline conditions.

The removal of decaying vegetation and actions to increase dissolved oxygen in the Comal Springs system and Landa Lake may affect the Comal Springs dryopid beetle's ability to respire, especially during periods of low flow or increased water temperature that would be expected during severe drought conditions. The effects of the action include the effects of these activities improving water quality during drought conditions over the conditions that would be expected during an equivalent drought period today.

The Comal Springs dryopid beetle is believed to primarily occupy subterranean areas within the aquifer. The species is also known from Comal Springs spring runs, upwellings and springs that occur some distance from shoreline, and from Panther Canyon well. Calculating the amount of potential take based on surface effects (such as drying of surface spring openings) to estimated surface populations, therefore, generates a total that likely overestimates the effects to the species. This factor provides some measure of conservatism in the calculations. We estimate a total surface population of Comal springs dryopid beetles in the Comal Springs system at1,839 individuals (Bowles and Stanford 2003, Gibson 2011).

Drying of surface habitat and spring orifices may affect the species and the availability of its required food resources in these areas during a repeat of DOR-like conditions. Under baseline conditions, a repeat of DOR-like precipitation and recharge would result in the projected cessation of flow at Comal Springs for 38-months or 36-months under today's maximum allowable pumping and recent average (2000 through 2010) pumping projections, respectively.

With implementation of the HCP, springflow at Comal Springs during a DOR–like event is projected to maintain continual flows that only dip below 30 cfs (0.85 cms) for 75 days under HCP Phase I and dip below 45 cfs (1.3 cms) for only 30 days under Phase II. Approximately 80% of the surface population of the species is associated with Comal Springs Runs # 1, # 2, and # 3. Under these conditions, the spring outlets near the western shoreline of Landa Lake and the upwellings near Spring Island are expected to continue to provide some flow and therefore to continue to support the needs of the species at these locations. The anticipated drying of Comal Springs Runs # 1, # 2, and # 3 during DOR-like conditions will result in displacement, injury, or death of up to 1,471 Comal Springs dryopid beetles.

Comal Springs dryopid beetle habitat could be affected by riparian restoration measures. These activities are not anticipated to occur during low flow or drought conditions. As discussed above, the Comal Springs dryopid beetle is primarily subterranean and aquatic and little of the species' habitat is associated with the riparian zone. Because a limited amount of surface habitat may be impacted by these actions, and relying on the simplifying assumption that individuals of the species are uniformly distributed through the habitat, we project that no more than 5% of the available surface habitat could be impacted by these actions during any particular year. If 10% of the individuals of the species within the impacted area are displaced, injured, or killed as a result of these impacts, a total of 9 individuals would be exposed to take per year as a result of these restoration measures. This represents approximately 0.4% of the surface-associated population of the species at Comal Springs. With little or no information about population dynamics, recruitment, or generation time for the species, we presume that adverse effects to less than half of one percent of that portion of the population associated with the surface habitat will result in little effect to demographics or survival of the species.

The short-term adverse effects associated with actions described above, such as management of non-native vegetation, restoration of native woody species, and riparian restoration measures are expected to generate long-term benefits to the Comal Springs dryopid beetle and its habitat in the Comal Springs system.

The total number of Comal Springs dryopid beetles subject to incidental take as a result of the action presuming a repeat of a seven-year DOR-like event and eight-years of additional impacts is an estimated 1,543 individuals. Because the species apparently survived the seven-year DOR event, and is believed to occur primarily in subterranean aquatic habitats within the aquifer, we believe that this level of take resulting from implementation of the HCP will not appreciably reduce the likelihood of survival and recovery of the species in the wild.

Effects of the action on designated critical habitat

Critical habitat for the species was designated in two units located at Comal Springs and Fern Bank Springs (72 FR 39248).

The effect of the action includes implementation of measures to reduce threats to water quality (as described above) that will decrease potential groundwater and surface water contamination and reduce threats to the species from exposure to these stressors over baseline conditions. The effects of the action, therefore, will reduce the threat of water contamination and contribute to the ability of the designated critical habitat unit at Comal Springs to continue to provide high quality water with minimal levels of pollutants.

Implementation of the measures proposed in the HCP will not affect water temperatures within the aquifer, and will therefore not affect springflow temperatures at Comal Springs. The effects of the action will not affect the ability of this designated critical habitat unit from continuing to provide this primary constituent element.

The action would result in implementation of the flow protection and springflow management measures described above. During periods of average precipitation and recharge the implementation of these measures will not affect aquifer levels impacting springflows at Comal Springs. The resulting effects of the action to designated critical habitat for the Comal Springs dryopid beetle during average precipitation and recharge conditions are discountable. During drought conditions the combined effects of these measures will maintain springflows at Comal Springs, thereby supporting the capacity of the designated critical habitat to provide flowing water and a hydrologic regime that supports the defined water quality parameters.

Riparian restoration measures may impact designated critical habitat at Comal Springs through substrate disturbance and increased turbidity. The short term adverse substrate and water quality impacts anticipated to occur while these activities are implemented, as well as the improved long-term capacity of restored habitat areas to provide food supplies required by the Comal Springs dryopid beetle described as a primary constituent element, are also effects of the action.

The hydrology at Fern Bank Springs is poorly understood, and multiple sources of the springwater at this location have been proposed (USFWS 1996a). Recent evidence suggests that the water at Fern Bank Springs may be sourced from areas south of the Blanco River (EAA 2010). If completely sourced from the Edwards Aquifer, implementation of the proposed measures described above would not be expected to prevent the designated critical habitat unit at this site from continuing to provide food supplies and appropriate water quality requirements described as primary constituents necessary for the conservation of the species. If Fern Bank Springs is only partially sourced from the Edwards Aquifer, or if all Fern Bank Springs water is derived from other sources, the HCP measures considered would also not prevent this location from continuing to provide these elements.

None of the measures proposed in the EARIP HCP will destroy or adversely modify the ability of the Comal Springs dryopid beetle designated critical habitat from providing the identified primary constituent elements required for the conservation of the species.

vi. Comal Springs riffle beetle

Effects of the action on the Comal Springs riffle beetle

Implementation of flow protection and springflow management measures that affect the Comal Springs riffle beetle include changes to EAA CPM pumping restrictions, the management and use of the SAWS ASR to support springflows, implementation of the VISPO program or equivalent necessary measures, and reductions of surface water diversions from Spring Lake and the San Marcos River. During periods of average precipitation and recharge, the indirect effects of regulation and production of groundwater and implementing these flow protection and springflow management measures will not affect aquifer levels impacting springflows at Comal or San Marcos Springs.

Reduction or loss of water quantity has been described as one of the main threats to the Comal Springs riffle beetle, and assuring increased flows during periods of drought may reduce the species' exposure to this effect. During drought conditions, the combined effect of the flow protection and springflow management measures and the increased aquifer levels generated by the RWC Program (described above) will maintain increased water levels within the aquifer and provide for greater springflows at Comal and San Marcos Springs than would be expected under equivalent conditions today.

The Comal Springs riffle beetle's specialized aquatic adaptations limit the species' ability to utilize new habitats or expand its range. The aquatic species cannot fly, and it has been suggested that they may be confined to small areas surrounding spring openings. The extent of the subterranean range of the species is unknown, though to date it is only known from natural spring openings at Comal and San Marcos Springs. These limitations to movement support suggestions that the species survived the DOR event by utilizing subterranean components of the aquifer and springs systems.

The various spring outlets in the Comal Springs system are located at different elevations above sea level. As aquifer levels fluctuate, therefore, springflows at each outlet reflect their relative elevation. At aquifer levels of approximately 622 feet (189.5 meters) above msl, Comal Spring Runs # 1 and # 2 cease to flow. This aquifer level corresponds with Comal springflows of approximately 130 cfs (3.7 cms). Spring Run # 3 ceases flowing at aquifer levels of about 620 feet (189 meters) above msl, which corresponds to Comal Springs flows of approximately 50 cfs (1.4 cms). Under the baseline conditions, a repeat of DOR-like conditions would result in the projected cessation of flow at Comal Springs for 38-months or 36-months under today's maximum allowable pumping and recent average (2000 through 2010) pumping projections, respectively.

Under a repeat of DOR-like conditions with implementation of the HCP, flows in Comal Springs maintain 27 cfs (0.76 cms) during HCP Phase I and 30 cfs (0.85 cms) during Phase II at Comal Springs. The effect of the action at Comal Springs, therefore, results in springflows that exceed both historic and projected current flow rates under DOR-like conditions. Figure 2 (above) illustrates the reported historic springflows and compares the effects of the baseline ("No Action") to HCP implementation (Alternatives 2a and 2b) at Comal Springs.

Though these flows will result in cessation of flow at Comal Spring Runs # 1, # 2, and # 3; water levels within Panther Canyon well and seeps along the western shoreline of Landa Lake and within upwellings near Spring Island are expected to continue to provide available habitat for the species. Comal Springs riffle beetles within spring Runs # 1, # 2, and # 3 may be able to utilize the subterranean portions of the aquifer and the springs during these conditions, though they will be displaced by the reduced springflows and may be injured or killed during these conditions.

Flow protection and springflow protection measures that maintain San Marcos Springs and flows within Spring Lake are expected to maintain water flows at the spring openings known to support the Comal Springs rifle beetle at this site during drought conditions equivalent to the DOR.

The effects of the action include the measures described above that reduce the potential for groundwater or surface water contamination. These measures will reduce these threats regardless of precipitation and recharge conditions. An indirect effect will be a resulting decrease in the species' potential exposure to contaminants when compared to baseline conditions.

Restoration of riparian zones including the removal of non-native vegetation and restoration of native woody species are planned minimization and mitigation measures in the HCP. The Comal Springs riffle beetle may be affected by these activities. Likely stressors associated with riparian zone restoration elements include substrate disturbance and increased turbidity. These impacts could result in harm or harassment resulting from displacement or injury. Comal Springs riffle beetles could be exposed to these stressors when in close proximity to restoration activities. The effects of the action include short term water quality effects and potential displacement or injury anticipated to occur while these activities are implemented. The effects of the action also include the reestablishment of native woody vegetation that supports the feeding needs of the species when compared to existing baseline conditions.

The removal of decaying vegetation and actions to increase dissolved oxygen in the Comal Springs system and Landa Lake may affect the Comal Springs riffle beetle's ability to respire, especially during periods of low flow or increased water temperature that would be expected during severe drought conditions. The effects of the action include the effects of these activities to improve water quality during drought conditions over the conditions that would be expected during an equivalent drought period today.

Sediment removal in Spring Lake may impact the Comal Springs riffle beetle. These activities may generate sediment disturbance and turbidity stressors in the short term in order to reduce sedimentation and total sediment load. These actions are intended to remove interstitial sedimentation and return Spring Lake substrates to a more natural condition. The habitat restoration and sediment removal activities that generate these stressors may result in harm or harassment through displacement or injury. The exposure to these stressors is only anticipated to occur during implementation of these measures and to be short in duration. These efforts are expected to result in lowered total sediment loads anticipated to provide long-term benefits to the species that are improvements over conditions in the existing baseline.

The HCP will reduce the introduction of and control non-native species to reduce competition and predation. Competition for food resources from non-native species (such as the snails *Marisa cornuarietis, Thiara granifera* and *Thiara tuberculata* present in the spring runs) has been identified as an ongoing threat to the continued survival of the Comal Springs riffle beetle. The effect of the action of reducing Comal Springs riffle beetle stressors from non-native species such as introduced snail species and predatory fishes would reduce exposure and minimize the effects of these existing threats.

Drying of surface habitat and spring orifices may affect the species and the availability of its required food resources in these areas during a repeat of DOR-like conditions. Approximately

90% of the Comal Springs riffle beetle habitats known to be occupied in the Comal Springs system are associated with the primary spring outlets. Under baseline conditions, a repeat of DOR-like precipitation and recharge would result in the projected cessation of flow at Comal Springs for 38-months or 36-months under today's maximum allowable pumping and recent average (2000 through 2010) pumping projections, respectively. With implementation of the HCP, springflow at Comal Springs during a DOR–like event is projected to maintain continual flows that only dip below 30 cfs (0.85 cms) for 75 days under HCP Phase I and dip below 45 cfs (1.3 cms) for only 30 days under Phase II. The spring outlets near the western shoreline of Landa Lake and the upwellings near Spring Island are expected to decline but to continue to provide some flow supporting the needs of the species at these locations. A total of approximately 10,739 Comal Springs riffle beetles would be displaced, injured, or killed in the Comal Springs system during a repeat of DOR-like conditions.

The impact of the taking during DOR-like conditions, therefore, could adversely impact the population at Comal Springs. The apparently rapid generation time and ability for the species to produce multiple broods each season suggest that the species may be capable of rapidly repopulating suitable habitats. We believe evidence suggests that the species successfully relied on subsurface habitats in the past to survive drought conditions, and that the species' persistence at Comal Springs following the DOR event supports this hypothesis. Because the effects of the action will maintain habitat conditions surpassing those experienced during the DOR, and while the effects of the taking at Comal Springs may have some population-level effects in the short term, we believe that the species is capable of surviving and repopulating these locations after an event of similar duration and intensity.

Comal Springs riffle beetles in Spring Lake are expected to survive DOR-like conditions, as the minimum continuous flows of 50 cfs (1.4 cms) are similar to those reported during the DOR which the species apparently survived in this location. Though some incidental take associated with the action may occur during these conditions in Spring Lake, the effects of the taking are not expected to exert a demographic or population-level effect on the population at this location under these conditions.

Habitat for the Comal Springs riffle beetle could be affected by riparian restoration measures. These activities are not anticipated to occur during low flow or drought conditions. As discussed above, the Comal Springs riffle beetle is aquatic and little of the species' habitat is associated with the riparian zone. Because a limited amount of surface habitat may be impacted by these actions, and relying on the simplifying assumption that individuals of the species are uniformly distributed through the habitat, we project that no more than 5% of the available surface habitat could be impacted by these actions during any particular year. If 10% of the individuals of the species within the impacted area are displaced, injured, or killed as a result of these impacts, a total of 55 individuals would be exposed to take per year as a result of these restoration measures. This represents approximately 0.5% of the surface-associated population of the species at Comal Springs. The Comal Springs riffle beetle displays overlapping generations, is apparently capable of multiple broods per season, and reportedly lives for six-months to three-years. We presume that adverse effects to less than half of one percent of the population will generate little effect to demographics or survival of the species in the Comal Springs system.

The short-term adverse effects associated with actions described above, such as management of non-native vegetation, restoration of native woody species, and riparian restoration measures are expected to generate long-term benefits to the Comal Springs riffle beetle and its habitat in the Comal and San Marcos Springs systems.

The total number of Comal Springs riffle beetles subject to incidental take as a result of the action presuming a repeat of a seven-year DOR-like event and eight-years of additional impacts is an estimated 11,179 individuals. Because the species apparently survived the seven-year DOR event, and is expected to persist in Spring Lake even during a repeat of DOR-like conditions, we believe that this level of take resulting from implementation of the HCP will not appreciably reduce the likelihood of survival and recovery of the species in the wild.

Effects of the action on designated critical habitat

Critical habitat for the species was designated in two units located at Comal Springs and San Marcos Springs (72 FR 39248).

The effect of the action includes measures to reduce threats to water quality (as described above) that will decrease potential groundwater and surface water contamination and reduce threats to the species from exposure to these stressors over baseline conditions. The effects of the action, therefore, will reduce the threat of water contamination and contribute to the ability of designated critical habitat units to continue to provide high quality water with minimal levels of pollutants described as a constituent element necessary for the conservation of the species.

Implementation of the measures in the HCP will not affect water temperatures within the aquifer, and will therefore not affect springflow temperatures at Comal or San Marcos Springs. The effects of the action will not affect the ability of designated critical habitat units from continuing to provide this primary constituent element.

The action would result in implementation of the flow protection and springflow management measures described above. During drought conditions the combined effects of these measures will maintain springflows at Comal and San Marcos Springs, thereby supporting the capacity of the designated critical habitat to provide flowing water and a hydrologic regime able to support the defined water quality parameters.

Riparian restoration measures may impact designated critical habitat through substrate disturbance and increased turbidity. The short term substrate and water quality impacts anticipated to occur while these activities are implemented, as well as the improved capacity of restored habitat areas to provide food supplies required by the Comal Springs dryopid beetle described as a primary constituent element, are also effects of the action.

Sediment removal measures at San Marcos Springs are intended to remove interstitial sedimentation and return Spring Lake substrates to a more natural condition to ensure that the designated critical habitat continues to provide the constituent element requiring gravel and cobble substrates that are free of sand and silt.

The effects of the action will not destroy or adversely modify the ability of the proposed designated critical habitat of the Comal Springs riffle beetle from providing the identified primary constituent elements required for the conservation of the species.

vii. Texas cave diving beetle

Effects of the action on the Texas cave diving beetle

Implementation of flow protection and springflow management measures that affect the Texas cave diving beetle include changes to EAA CPM pumping restrictions, the management and use of the SAWS ASR to support springflows, implementation of the VISPO program or equivalent necessary measures, and reductions of surface water diversions from Spring Lake and the San Marcos River. During periods of average precipitation and recharge, the effects of regulation and production of groundwater and implementing these flow protection and springflow management measures will not affect aquifer levels impacting springflows at Comal or San Marcos Springs.

Groundwater pumping has been described as a major threat to the Texas cave diving beetle, and assuring increased flows during periods of drought may reduce the species' exposure to this effect. During drought conditions, the combined effect of the flow protection and springflow management measures and the increased aquifer levels generated by the RWC Program (described above) will maintain increased water levels within the aquifer and provide for greater springflows at Comal and San Marcos Springs than would be expected under equivalent conditions today.

The effects of the action include the measures described above that reduce the potential for groundwater or surface water contamination. These measures will reduce these threats regardless of precipitation and recharge conditions. An indirect effect will be a resulting decrease in the species' potential exposure to contaminants when compared to baseline conditions.

Because no quantitative data estimating population size of the Texas cave diving beetle is available, habitat impacts are relied on as a surrogate parameter to estimate effects to the species that could constitute take. The HCP measures described above are anticipated to maintain aquifer levels and springflows generally supportive of the species' needs, though some drying of surface habitat near spring orifices that may affect the availability of food resources could occur during a repeat of DOR-like conditions. Because the species is believed to have survived the seven-year DOR event; and the effects of the action will maintain springflows at levels that mimic those historic conditions, we find that the effects of the incidental take resulting from implementation of the HCP will not appreciably reduce the likelihood of the survival of the species in the wild.

Effects of the action on designated critical habitat

The Texas cave diving beetle is not currently listed as threatened or endangered, and therefore no critical habitat has been designated and none will be affected.

viii. Texas troglobitic water slater

Effects to the Texas troglobitic water slater

Implementation of flow protection and springflow management measures that affect the Texas troglobitic water slater include changes to EAA CPM pumping restrictions, the management and use of the SAWS ASR to support springflows, implementation of the VISPO program or equivalent necessary measures, and reductions of surface water diversions from Spring Lake and the San Marcos River. During periods of average precipitation and recharge, the indirect effects of regulation and production of groundwater and implementing these flow protection and springflow management measures will not affect aquifer levels or springflows at San Marcos Springs.

Aquifer drawdown has been described as a threat to the Texas troglobitic water slater, and assuring increased flows during periods of drought may reduce the species' exposure to this effect. During drought conditions, the combined effect of the flow protection and springflow management measures and the increased aquifer levels generated by the RWC Program (as described above) will maintain increased water levels within the aquifer and provide for greater aquifer levels and springflows at San Marcos Springs than would be expected under equivalent conditions today.

The effects of the action include the measures described above that reduce the potential for groundwater or surface water contamination. These measures will reduce these threats regardless of precipitation and recharge conditions. An indirect effect will be a resulting decrease in the species' potential exposure to contaminants when compared to baseline conditions.

Because no quantitative data estimating population size of the Texas troglobitic water slater is available, habitat impacts are relied on to estimate effects to the species that could constitute take. The HCP measures described above are anticipated to maintain aquifer levels and springflows generally supportive of the species' needs, though some drying of surface habitat near spring orifices that may affect the availability of food resources could occur during a repeat of DOR-like conditions. Because the species is believed to have survived the seven-year DOR event, and the effects of the action will maintain springflows at levels that mimic those historic conditions, we find that effects of the incidental take resulting from implementation of the HCP will not appreciably reduce the likelihood of survival and recovery of the species in the wild.

Effects of the action on designated critical habitat

The Texas troglobitic water slater is not currently listed as threatened or endangered, and therefore no critical habitat has been designated and none will be affected.

ix. Peck's cave amphipod

Effects of the action to Peck's cave amphipod

Implementation of flow protection and springflow management measures that affect Peck's cave amphipod include changes to EAA CPM pumping restrictions, the management and use of the SAWS ASR to support springflows, and implementation of the VISPO program or equivalent necessary measures. During periods of average precipitation and recharge, the indirect effects of regulation and production of groundwater and implementing these flow protection and springflow management measures will not affect aquifer levels impacting springflows at Comal Springs.

Reduction or loss of water quantity has been described as one of the main threats to Peck's cave amphipod, and ensuring increased flows during periods of drought may reduce the species' exposure to this effect. During drought conditions, the combined effect of the flow protection and springflow management measures and the increased aquifer levels generated by the RWC Program will maintain increased water levels within the aquifer and provide for greater springflows at Comal Springs than would be expected under equivalent conditions today. The effect of the action at Comal Springs, therefore, results in continual minimum springflows that exceed both historic and projected current flow rates under DOR-like conditions.

The extent of the subterranean range of the Peck's cave amphipod is unknown. The eyeless unpigmented species is generally believed to be primarily associated with deep subterranean environments, and has only been found at Comal Springs, Hueco Springs, and Panther Canyon well. The species persistence at these locations and apparent limitations to movement support suggestions that the species survived the DOR event by utilizing subterranean components of the aquifer and springs systems.

The various spring outlets in the Comal Springs system are located at different elevations above sea level. As aquifer levels fluctuate, therefore, springflows at each outlet reflect their relative elevation. At aquifer levels of approximately 622 feet (189.5 meters) above msl, Comal Spring Runs # 1 and # 2 cease to flow. This aquifer level corresponds with Comal springflows of approximately 130 cfs (3.7 cms). Spring Run # 3 ceases flowing at aquifer levels of about 620 feet (189 meters) above msl, which corresponds to Comal Springs flows of approximately 50 cfs (1.4 cms). Under a repeat of DOR-like conditions, flows in Comal Springs will decline to 27 cfs (0.76 cms) during HCP Phase I and 30 cfs (0.85 cms) during Phase II at Comal Springs for short periods. These flows will result in cessation of flow at Comal Spring Runs # 1, # 2, and # 3, though water levels within Panther Canyon well and seeps along the western shoreline of Landa Lake and within upwellings near Spring Island are expected to continue to provide available habitat for the species. Peck's cave amphipods within Spring Runs # 1, # 2, and # 3 may be able to utilize the subterranean portions of the aquifer and the springs during these conditions, though they will be displaced by the reduced springflows and may be injured or killed during these conditions.

The various spring outlets at Hueco Springs have reportedly ceased flowing under various drought conditions. The effect of the action, however, is expected to generate increases in aquifer levels that may provide some support for continued springflows at Hueco Springs, though no data is available to assess the certainty and magnitude of this potential effect. The persistence of the species at this location despite the multiple recorded incidences of drought-induced cessation of flow further supports suggestions that the species relies primarily on the subterranean aquatic habitats rather than the surface expressions of the Edwards Aquifer.

The effect of the action includes measures to protect and enhance water quality (as described above) that will decrease potential groundwater and surface water contamination and reduce threats to Peck's cave amphipod from exposure to these stressors over conditions found today. The effects of the action, therefore, will reduce the threat of water contamination and reduce the potential for the species to be exposed to these threats.

Restoration of riparian zones including the removal of non-native vegetation and restoration of native woody species are planned minimization and mitigation measures in the HCP. Peck's cave amphipod may be affected by these activities. Likely stressors associated with riparian zone restoration elements include substrate disturbance and increased turbidity. These impacts could result in harm or harassment resulting from displacement or injury. Peck's cave amphipods could be exposed to these stressors when in close proximity to restoration activities. The effects of the action include short term water quality effects and potential displacement or injury anticipated to occur while these activities are implemented. The effects of the action also include the reestablishment of native woody vegetation that supports the feeding needs of the species when compared to existing baseline conditions.

Peck's cave amphipod is believed to primarily occupy subterranean areas within the aquifer and near spring openings. Calculating the amount of potential take based on surface effects (such as drying of surface spring openings) to estimated surface populations, therefore, generates a total that likely overestimates the overall effects to the species. This factor provides some measure of conservatism in the calculations. We estimate a total surface population of Peck's cave amphipods in the Comal Springs system at 21,700 based on sampling data reported to the Service (Bowles and Stanford 2003, Gibson et al 2008).

Drying of surface habitat and spring orifices may affect the species and the availability of its required food resources in these areas during a repeat of DOR-like conditions. Under baseline conditions, a repeat of DOR-like precipitation and recharge would result in the projected cessation of flow at Comal Springs for 38-months or 36-months under today's maximum allowable pumping and recent average (2000 through 2010) pumping projections, respectively. With implementation of the HCP, springflow at Comal Springs during a DOR–like event is projected to maintain continual flows that only dip below 30 cfs (0.85 cms) for 75 days under HCP Phase I and dip below 45 cfs (1.3 cms) for only 30 days under Phase II. The spring outlets near the western shoreline of Landa Lake and the upwellings near Spring Island are expected to decline but to continue to provide flow supporting the needs of the species at these locations. Approximately 80% of the estimated surface populations of Peck's cave amphipods are associated with Comal Spring Runs # 1, # 2 and # 3, and these individuals will be subject to displacement, injury or death during these conditions. Approximately 17,360 Peck's cave amphipods will be subject to take during a repeat of DOR-like conditions in the Comal Springs system.

The impact of the taking during DOR-like conditions, therefore, could impact Peck's cave amphipods at Comal Springs. We believe evidence suggests that the species successfully relied on subsurface habitats in the past to survive drought conditions, and that the species' persistence at Comal Springs following the DOR event supports this hypothesis. Because the effects of the action will maintain habitat conditions surpassing those experienced during the DOR, and while the effects of the taking at Comal Springs may have some population-level effects in the short term, we believe that the species is capable of surviving and repopulating these locations after an event of similar duration and intensity.

As described above, Peck's cave amphipod habitat could be affected by riparian restoration measures. These activities are not anticipated to occur during low flow or drought conditions. Peck's cave amphipod is believed to primarily occupy subterranean areas within the aquifer. The species is also known from upwellings and springs that occur some distance from shoreline and from the Panther Canyon well. The species is primarily subterranean and entirely aquatic and little of the species' habitat is therefore associated with the riparian zone. Because a limited amount of surface habitat may be impacted by these actions, and relying on the simplifying assumption that individuals of the species are uniformly distributed through the habitat, we project that no more than 5% of the available surface habitat could be impacted by these actions during any particular year. If 10% of the individuals of the species within the impacted area are displaced, injured, or killed as a result of these impacts, a total of 108 individuals would be exposed to take per year as a result of these restoration measures. This represents approximately 0.5% of the surface-associated population of the species at Comal Springs. With little or no information about population dynamics, recruitment, or generation time for the species, we presume that adverse effects to less than half of one percent of that portion of the population associated with the surface habitat will result in little effect to demographics or survival of the species.

The short-term adverse effects associated with actions described above, such as management of non-native vegetation, restoration of native woody species, and riparian restoration measures are expected to generate long-term benefits to the Peck's cave amphipod and its habitat in the Comal Springs system.

The total number of Peck's cave amphipods subject to incidental take as a result of the action presuming a repeat of a seven-year DOR-like event and eight-years of additional impacts is an estimated 18,224 individuals. Because the species apparently survived the seven-year DOR event and is believed to occur primarily in subterranean aquatic habitats within the aquifer, we believe that the impacts of the taking resulting from implementation of the HCP will not appreciably reduce the likelihood of survival and recovery of the species in the wild.

Effects of the action on designated critical habitat

Critical habitat for the species was designated in two units located at Comal Springs and Hueco Springs (72 FR 39248).

The effect of the action includes measures that will reduce threats to water quality (as described above), decrease potential groundwater and surface water contamination, and reduce threats to the species from exposure to these stressors over baseline conditions. The effects of the action, therefore, will reduce the threat of water contamination and contribute to the ability of the designated critical habitat unit at Comal Springs to continue to provide high quality water with minimal levels of pollutants.

Implementation of the measures proposed in the HCP will not affect water temperatures within the aquifer, and will therefore not affect springflow temperatures. The effects of the action will not affect designated critical habitat from continuing to provide this primary constituent element.

The action would result in implementation of the flow protection and springflow management measures described above. During drought conditions the combined effects of these measures will maintain springflows at Comal Springs, thereby supporting the capacity of the designated critical habitat to provide flowing water and a hydrologic regime that supports the defined water quality parameters. These measures will increase aquifer levels that may provide some support for continued springflows at Hueco Springs, though no data is available to assess the certainty and magnitude of this potential effect.

Riparian restoration measures may impact designated critical habitat at Comal Springs through substrate disturbance and increased turbidity. The short term substrate and water quality impacts anticipated to occur while these activities are implemented, as well as the improved capacity of restored habitat areas to provide food supplies required by Peck's cave amphipod described as a primary constituent element, are also effects of the action.

The effects of the action will not destroy or adversely modify the ability of the designated critical habitat of the Comal Springs riffle beetle from providing the identified primary constituent elements required for the conservation of the species.

x. Fountain darter

Effects of the action on the fountain darter

Implementation of flow protection and springflow management measures that affect the fountain darter include changes to EAA CPM pumping restrictions, the management and use of the SAWS ASR to support springflows, implementation of the VISPO program or equivalent necessary measures, and reductions of surface water diversions from Spring Lake and the San Marcos River. During periods of average precipitation and recharge the indirect effects of regulation and production of groundwater and implementing these flow protection and springflow management measures will not affect aquifer levels impacting springflows at Comal and San Marcos Springs and the respective Comal and San Marcos Rivers.

Reduced springflow is considered one of the primary threats to the fountain darter. The combined effect of the flow protection and springflow management measures during periods of drought and the increased aquifer levels generated by the RWC Program will maintain increased water levels within the aquifer and provide for greater flows at Comal and San Marcos Springs than would be expected under equivalent conditions today. The effects of the action, therefore, will decrease fountain darter exposure to reduced springflow in Comal Springs, Landa Lake and the Comal River; and in San Marcos Springs, Spring Lake and the San Marcos River.

The loss of water quality is also identified as a primary threat to the fountain darter. The effects of the action include the measures described above that reduce the potential for groundwater or surface water contamination. These measures will reduce these threats regardless of precipitation and recharge conditions. An indirect effect will be a resulting decrease in the species' potential exposure to contaminants when compared to baseline conditions.

The flow-split management measure is intended to mimic natural flow patterns within the new and old channels of the Comal River during average or above average precipitation and recharge conditions, and ensure that targeted minimum flows supportive of fountain darters and their habitat are directed through the Old Channel during low flow conditions. The effects of the action include the replacement and repair of gates and control mechanisms that allow manipulation of water flow. This measure could result in the displacement, injury, or death of fountain darters in close proximity to these activities. These activities are also likely to generate substrate disturbance and turbidity that may degrade water quality. These impacts, however, are expected to be short in duration and exposure to these threats will be limited to the period during which the actions are being implemented. The effects of the action also include the resulting restoration of flow pattern variability beneficial to native aquatic vegetation and the fountain darter.

This measure assures flows supportive of fountain darters and their habitats are available during drought conditions. In a repeat of DOR-like conditions, flows of no less than 20 cfs (0.56 cms) will be directed through the Old Channel at all times. Models projecting these flows in the Old Channel during ambient conditions expected during the peak of local summertime conditions illustrate resulting water temperatures that exceed the thermal threshold triggering reduced fountain darter egg production. Water temperatures remain, however, below the laboratory-determined thermal maxima for juvenile and adult survival (91° to 94°F [32.7° to 34.4°C]) during these conditions. The effects of the action, therefore, include maintenance of survivable conditions for juvenile and adult fountain darters within the old channel of the Comal River during a repeat of DOR-like conditions that would not be expected to receive any flow without implementation of the EARIP Conservation Program.

The management of water-based recreation associated with both the Comal and San Marcos River systems. The removal or reduction of threats associated with recreational use of the Comal and San Marcos Rivers is specifically called for in the Recovery Plan for the fountain darter (Service 1996a). These actions will increase public awareness of the species, reduce the effects of bankside erosion, and reduce impacts associated with disturbance of stream floor habitats including runs, riffles, and pools, and the mix of submergent aquatic vegetation that are important components of the species' habitat. Permanent access points with educational signage and kiosks will reduce the creation and use of unauthorized trails and access areas that erode river banks, contribute sediment loads and generate turbidity. Recreational uses that physically alter habitats or that result in loss of aquatic vegetation, such as trampling or uprooting vegetation, may harass or harm fountain darters or their habitat. Fountain darters reproduce by adhering eggs to aquatic plants (Dowden 1968, Phillips and Alexander unpublished data). Impacts to vegetation that supports fountain darter eggs could result in take. Managing recreation will reduce the species exposure to and thereby reduce the effects of human use of the Rivers when compared to current conditions.

The HCP proposes establishment of an Old Channel Environmental Restoration and Protection Area (ERPA) to minimize the impacts of recreation and pumping during low flow conditions. Efforts within this area include non-native aquatic vegetation management and sediment removal to restore fountain darter habitat. These activities are detailed below.

Implementation of non-native plant control actions may affect fountain darters in the Comal and San Marcos Spring systems and their designated critical habitat in Spring Lake and the San Marcos River. Fountain darters rely on a mixture of submergent aquatic vegetation types for shelter and breeding substrates. These activities are intended to improve habitat suitability by removing non-native plants that compete with native aquatic vegetation for space, light and nutrients. Likely stressors associated with non-native vegetation control program elements could include substrate disturbance, increased turbidity, and physical disturbance and removal of plants that may bear fountain darter eggs. Fountain darters exposed to these stressors could be harmed or harassed when in close proximity to the restoration activities or in the downstream flow path of plumes of turbidity resulting from these actions. The effects of the action include short-term changes to water quality and natural substrates and the direct loss of breeding substrates that could result in harm or harassment from displacement, injury, or death. These measures are expected to enhance habitat suitability by restoring native vegetation types that support fountain darter breeding, feeding and sheltering activities.

Sediment removal, including the island downstream of the Springfed Pool in the Comal River and Sessom's Creek sand bar removal in the San Marcos River, may also affect the species. These actions are proposed to reduce threats posed by loss of suitable habitat resulting from sedimentation and impacts to natural substrates in the Comal and San Marcos Rivers. Stressors associated with these measures include substrate disturbance and increased turbidity. Fountain darters exposed to these stressors when are in close proximity to the restoration activities or in the downstream flow path of plumes of turbidity resulting from these actions could be harmed or harassed. These potential changes to water quality and disturbances to natural substrates are expected to occur while these measures are being implemented, and exposure to these stressors is therefore anticipated to be short in duration. The effects of the action, therefore, include short duration exposure to degraded water quality and substrate disturbance; and reduced exposure to sedimentation and impacts to natural substrates when compared to baseline conditions.

The programs intended to reduce the introduction of and control non-native species to reduce threats such as competition, habitat disturbance, and parasitic infection associated with these species. Many of the non-native species in these systems are the result of "aquarium dumps", in which pet owners release the contents of unwanted fish tanks directly into the water bodies. Introduced suckermouth catfishes (*Loricaridae*) common in the pet trade are now found in the Comal and San Marcos River systems, and disrupt substrates and may burrow into and destabilize riverbanks thereby introducing additional sediment loads and turbidity. Nutria are semi-aquatic burrowing rodents native to South America now found in the San Marcos River system that are known to burrow into riverbanks and also increasing turbidity and sedimentation. The HCP will implement actions to address a non-native parasitic trematode that threatens fountain darters by attacking the fish's gills (Mitchell et al. 2000, McDonald et al. 2006). Reducing introductions and controlling populations of the non-native snails that serve as intermediate hosts for the parasite could reduce the effects of this threat. The effects of the action include reducing the incidence of these introductions and controlling populations of non-native species. These measures will reduce exposure to degraded water quality and minimize effects from these threats over the environmental baseline.

The removal of decaying vegetation and actions to increase dissolved oxygen in the Comal Springs system and Landa Lake may affect the fountain darter, especially during periods of low flow or increased water temperature that would be expected during severe drought conditions. The effects of the action include the results of these activities to improve water quality during drought conditions over the conditions that would be expected during an equivalent drought period today.

The HCP projects that the fountain darter could experience population losses of up to 95% in the Comal River system during a repeat of DOR-like conditions (see HCP 4.2.2.1). During these conditions, flows at Comal Springs will decline to 27 cfs (0.76 cms) for a limited period during the height of the DOR. Modeling found that daily average flows of 30 cfs (0.85 cms) (with 20 cfs [0.56 cms] directed down the Old Channel, and 10 cfs [0.28 cms] directed through the new channel) for no more than six-months to be followed by at least three-months of flows of 80 cfs (2.27 cms) will continue to support juvenile and adult fountain darters and maintain some limited recruitment (Hardy 2010). Springflow modeling of DOR-like conditions finds that continual flows will be maintained at Comal Springs and will dip below 30 cfs (0.85 cms) for no more than 75 days during HCP Phase I and will never fall to this level during Phase II (see HCP Section 4.2.1.3). By comparison, the baseline modeling indicates a cessation of flow for 38-months under maximum permitted pumping or 36-months under recent observed pumping totals. A total of 735,000 fountain darters will be subject to displacement, injury, or death as a result of the action during a repeat of DOR-like conditions on the Comal River system.

During these conditions, the fountain darter could experience population losses estimated to range between 50 to 94% in the San Marcos River system (see HCP 4.2.2.2). This range reflects uncertainties in the modeling associated with projecting flows at the extremely low levels in the San Marcos System for which there are no historic precedents. During these conditions, continual flows will be maintained in the San Marcos River, and flows will dip to approximately 50 cfs (1.4 cms) for no more than 30 days during HCP Phase I and for 15 days during Phase II (see HCP Section 4.2.1.3). During a repeat of DOR-like conditions, up to 450,000 fountain darters in the San Marcos River will be subject to displacement, injury, or death as a result of the action.

The Fountain darter survived the DOR in Spring Lake and the San Marcos River, and the effects of the action include flow protection and springflow management measures that mimic historic conditions. Fountain darters in Spring Lake are therefore expected to survive a repeat of DOR-like conditions, as the minimum continuous flows of 50 cfs (1.4 cms) are modeled to maintain habitat suitability and water quality parameters supportive of all life stages. Though some incidental take may be associated with these conditions in Spring Lake, the effects of the taking at this location are not expected to result in demographic or population-level effects.

We project that up to 10% of fountain darter habitat could be affected by sediment removal, water-based recreation, non-native species management, operation and maintenance of flow management infrastructure, and other considered activities in any year of average conditions in the Comal System and the San Marcos River; and that up to 10% of the fountain darters in impacted areas may be displaced, injured, or killed as a result of these impacts. We project that no more than 2.5% (or approximately 10,350 square feet [961 square meters]) of suitable fountain darter habitat in Spring Lake will be impacted by these factors on an annual basis, and that a similar 10% of affected fountain darters will be displaced, injured, or killed as a result of these activities. Based on the reported fountain darter population densities for these systems described above, these impacts will generate incidental take of up to 7,750 fountain darters per year in the Comal system, up to 4,800 in the San Marcos River, and up to 7,591 per year in Spring Lake.

The total number of fountain darters subject to incidental take as a result of the action presuming a repeat of a seven-year DOR-like event and eight-years of additional impacts is an estimated 797,000 individuals in the Comal Springs system, and 549,129 individuals in Spring Lake and the San Marcos system. Because the minimization and mitigation measures proposed in the HCP are anticipated to maintain springflows supportive of all life stages during DOR-like conditions in Spring Lake, and to maintain conditions supportive of some proportion of the fountain darter population in the Comal and San Marcos Rivers, we believe that the impacts of the taking resulting from implementation of the HCP will not appreciably reduce the likelihood of survival and recovery of the species in the wild.

Effects of the action on designated critical habitat

Critical habitat for the fountain darter includes Spring Lake and the San Marcos River downstream to 0.5 mile (0.8 kilometers) past Interstate 35 (45 FR 47355).

The action results in implementation of the flow protection and springflow management measures described above. During drought conditions the combined effects of these measures will maintain springflows at San Marcos Springs, thereby maintaining this required element of designated critical habitat.

The HCP includes measures to reduce threats to water quality (as described above) that will reduce the probability of a spill or other release the San Marcos River and its tributaries, and decrease potential groundwater and surface water contamination. The effects of the action, therefore, will reduce the threat of water contamination and support the ability of the designated critical habitat units to continue to provide high quality water with minimal levels of pollutants.

Implementation of the measures proposed in the HCP will not affect water temperatures within the aquifer, and will therefore not affect springflow temperatures at San Marcos Springs. The effects of the action will not affect the ability of designated critical habitat to continue to provide water within normally observed temperature variances.

The effects of the action will result in implementation of HCP measures that will generate indirect adverse water quality impacts, such as turbidity associated with habitat restoration measures, targeted removal of non-native vegetation, sediment removal, and Sessom's Creek sandbar removal measures. In each case, however, these effects are anticipated to be short induration, and will not destroy or adversely modify the ability of designated critical habitat to provide appropriate water quality.

Various HCP measures will also result in some disturbance of habitats and natural substrates. These measures include habitat restoration measures, targeted removal of non-native vegetation, sediment removal, and Sessom's Creek sandbar removal. These effects are also anticipated to be experienced only while the measures are being implemented, and will not result in the destruction or adverse modification of the habitats or natural substrates required for the conservation of the fountain darter.

xi. San Marcos gambusia

Effects of the action on the San Marcos gambusia

The San Marcos gambusia has not been collected since 1982, and may no longer exist in the wild. The species has not, however, been declared extinct or removed from the list of endangered species and must therefore be addressed in this biological opinion.

Implementation of flow protection and springflow management measures that affect the San Marcos gambusia include changes to EAA CPM pumping restrictions, the management and use of the SAWS ASR to support springflows, implementation of the VISPO program or equivalent necessary measures, and reductions of surface water diversions from Spring Lake and the San Marcos River. During periods of average precipitation and recharge the indirect effects of regulation and production of groundwater and implementing these flow protection and springflow management measures will not affect aquifer levels impacting springflows at San Marcos Springs and the San Marcos River.

The combined effect of the flow protection and springflow management measures during periods of drought and the increased aquifer levels generated by the RWC Program (described above) will maintain increased water levels within the aquifer and provide for greater flows at San Marcos Springs and in the San Marcos River than would be expected under equivalent conditions today. The effects of the action, therefore, will decrease the species' exposure to reduced springflow in the San Marcos River.

The loss of water quality is also identified as a primary threat to the San Marcos gambusia. The effects of the action include the measures described above that reduce the potential for groundwater or surface water contamination. These measures will reduce these threats regardless of precipitation and recharge conditions. An indirect effect will be a resulting decrease in the species' potential exposure to contaminants when compared to baseline conditions.

The effects of the action includes resulting impacts associated with implementation of non-native plant control actions may affect San Marcos gambusia. The San Marcos gambusia inhabits open areas with little vegetation, and reducing non-native aquatic plant coverage may improve habitat suitability for this species. Control of non-native plants such as Elephant ears (*Colocasia esculenta*) could affect San Marcos gambusia habitats. Some researchers have hypothesized that this non-native species may have adversely affected habitat suitability for the species (Service 1996). Though removal of non-native vegetation may generate short-term negative effects, these efforts could help restore the San Marcos River to conditions more similar to those with which the San Marcos gambusia evolved. Stressors that may arise from non-native vegetation control actions could include substrate disturbance that generates increased turbidity. San Marcos gambusia exposed to these stressors when in close proximity to the restoration activities or in the downstream flow path of resulting plumes of turbidity could be harmed or harassed. These potential changes to water quality and natural substrates that are effects of the action are expected to be short in duration and to occur during implementation of the actions. The resulting restoration of conditions is anticipated to improve habitat suitability over existing baseline conditions and maintain open areas with little vegetation that identified as important to the conservation of the species within designated critical habitat. These short-term adverse effects are expected to generate long-term benefits to San Marcos gambusia habitat.

The effects of the action include Sessom's Creek sand bar removal and sediment removal in the San Marcos River that may affect the species. These measures are intended to reduce the threats posed by loss of suitable habitat resulting from sedimentation and impacts to natural substrates in the San Marcos River. These activities are likely to generate sediment disturbance and turbidity that while reducing total sediment loads. San Marcos gambusia could be exposed to these stressors when are in close proximity to the restoration activities or in the downstream flow path of plumes of turbidity resulting from these actions. These impacts to water quality and natural substrates could result in short-term adverse effects that generate long-term benefits to San Marcos gambusia habitat. The resulting restoration of conditions to a more natural condition is expected to improve habitat suitability for the species over current conditions.

The programs intended to reduce the introduction of and control non-native species to reduce threats such as competition, and habitat disturbance associated with these species. Many of the non-native species in these systems are the result of "aquarium dumps", in which pet owners release the contents of unwanted fish tanks directly into the rivers. Species such as suckermouth catfishes (*Loricaridae*) that are common in the pet trade are now found in the San Marcos River. These armored catfishes disrupt substrates and may burrow into and destabilize riverbanks, thereby introducing additional sediment loads and turbidity into the river. Nutria are semi-aquatic burrowing rodents native to South America now found in the San Marcos River system that are known to burrow into riverbanks and also increasing turbidity and sedimentation. These measures could reduce exposure and thereby minimize the effects of these threats over the baseline condition.

The effects of the action will support and improve habitat for the San Marcos gambusia in the San Marcos River. However, because the San Marcos gambusia may no longer exist in the wild, take, harm, or harassment are not reasonably certain to occur.

Effects of the action on designated critical habitat

The designated critical habitat for the species includes the San Marcos River from Highway 12 Bridge downstream to approximately 0.5 miles (0.8 km) below Interstate Highway 35 Bridge (45 FR 47355).

The action would result in implementation of the flow protection and springflow management measures described above. During drought conditions the combined effects of these measures will maintain flows within the San Marcos River, thereby maintaining this element of designated critical habitat.

Implementation of the measures proposed in the HCP will not affect water temperatures within the aquifer, and will therefore not affect springflow temperatures or water temperatures within the designated stretch of the San Marcos River. The effects of the action will not affect the ability of designated critical habitat to continue to provide water within normally observed temperature variances.

The effects of the action will result in implementation of habitat restoration efforts that will maintain open areas by removing non-native vegetation within the River. None of the measures proposed in the HCP or the effects of those measures are expected to destroy or modify habitat in any way that would prevent these areas from continuing to provide the elements required by the species.

Various HCP measures will also result in some disturbance of habitats and natural substrates. These measures include habitat restoration measures, targeted removal of non-native vegetation, sediment removal, and Sessom's Creek sandbar removal. These short-term adverse effects will be experienced only while the measures are being implemented, will not result in the destruction or adverse modification of the habitats or natural substrates, and are expected to generate long-term benefits to San Marcos gambusia habitat.

xii. San Marcos salamander

Effects of the action on the San Marcos salamander

The San Marcos salamander may be affected by implementation of flow protection and springflow management measures including changes to EAA CPM pumping restrictions, the management and use of the SAWS ASR to support springflows, implementation of the VISPO program or equivalent necessary measures, and reductions of surface water diversions from Spring Lake and the San Marcos River. During periods of average precipitation and recharge the indirect effects of regulation and production of groundwater and implementing these flow protection and springflow management measures will not affect aquifer levels impacting springflows at San Marcos Springs and the San Marcos River.

Reduced springflow is considered one of the primary threats to the San Marcos salamander. The combined effect of the flow protection and springflow management measures during periods of drought and the increased aquifer levels generated by the RWC Program will maintain increased water levels within the aquifer and provide for greater flows at San Marcos Springs and in the

San Marcos River than would be expected under equivalent conditions today. The effects of the action, therefore, will decrease the species' exposure to reduced springflow in the San Marcos River.

The San Marcos salamander is also threatened by the potential loss of water quality at San Marcos Springs. The effects of the action include the measures described above that reduce the potential for groundwater or surface water contamination. These measures will reduce these threats regardless of precipitation and recharge conditions. An indirect effect will be a resulting decrease in the species' potential exposure to contaminants when compared to baseline conditions.

Sediment and removal activities may also affect the San Marcos salamander. This measure will restore the sand, gravel, and rock substrates utilized by the species that are currently affected by sedimentation in Spring Lake and portions of the San Marcos River. Stressors associated with these measures include substrate disturbance and increased turbidity. San Marcos salamanders exposed to these stressors when are in close proximity to the restoration activities or in the flow path of plumes of turbidity resulting from these actions could be harmed or harassed through displacement or injury. These potential changes to water quality and disturbances to natural substrates are expected to occur while these measures are being implemented, and exposure to these stressors is therefore anticipated to be short in duration. The effects of the action, therefore, include short duration exposure to degraded water quality and substrate disturbance; and reduced exposure to the negative impacts of sedimentation of natural substrates when compared to baseline conditions.

The removal or reduction of threats associated with recreational use of the San Marcos River is specifically called for in the Recovery Plan for the San Marcos salamander (Service 1996a). These actions are proposed to increase public awareness of the species and to reduce impacts associated with habitat impacts such as exposure or disturbance of algal mats, mosses, other plants, or Spring Lake substrates. Recreational uses that physically alter habitats or that result in loss of aquatic vegetation, such as disturbance from SCUBA divers, or trampling or uprooting vegetation, may harm or harass the species. Managing recreation could reduce the San Marcos salamander's exposure to these impacts and thereby reduce the effects of human recreation in these areas over current conditions.

The measures intended to reduce the introduction of and control non-native species to reduce threats such as habitat disturbance and predation associated with these species. Many of the non-native species in these systems are the result of "aquarium dumps", in which pet owners release the contents of unwanted fish tanks directly into the water bodies. Introduced suckermouth catfishes (*Loricaridae*) common in the pet trade are now found in the Comal and San Marcos River systems, and disrupt substrates and may burrow into and destabilize riverbanks thereby introducing additional sediment loads and turbidity. Nutria are semi-aquatic burrowing rodents native to South America now found in the San Marcos River system that are known to burrow into riverbanks and also increasing turbidity and sedimentation. The non-native blue tilapia (*Oreochromis aureus*) is now common within Spring Lake and San Marcos. Blue tilapia are omnivorous and likely prey on San Marcos salamanders. Reducing the incidence of these introductions and controlling populations of non-native species could reduce exposure to these stressors and minimize effects from these threats.

We estimate that suitable habitat for the San Marcos salamander currently covers about 29,600 square feet (2,750 square meters) in the uppermost San Marcos River immediately below Spring Lake Dam and approximately 332,500 square feet (30,890 square meters) within Spring Lake (Bio-West 2005). The following take projections are believed to be conservative, as they calculate impacts based only on surface area of suitable habitat. The San Marcos salamander is known to use subsurface interstitial spaces that are difficult to describe with available sampling and modeling methods. Projecting take based solely on expected surface impacts, therefore, is expected to underestimate total effects that may be experienced. These calculations also do not take into account the protective measures anticipated to result from the newly established State Scientific Area. The San Marcos salamander habitat within the San Marcos River below Spring Lake dam falls within the area that will be managed under this designation once springflows fall below 120 cfs (3.4 cms). The impacts of recreation to the species and its habitats are expected to be minimized by this measure during these conditions.

The HCP projects that during a repeat of DOR-like conditions, the San Marcos salamander could experience population losses of up to 90% in the eastern spillway below Spring Lake dam, and approximately 60% reductions in the sample areas within Spring Lake (see HCP 4.2.2.2). Relying on the simplifying assumptions that these approximations hold true for the related habitat areas within the upper San Marcos River and Spring Lake respectively, that populations are best represented by the median salamander densities recorded during the 2002-2010 sampling period (0.52 per square foot [5.5 per square meter] within suitable habitat in the San Marcos River below Spring Lake dam, and 1.1 salamanders per square foot [11.8 per square meter] within suitable habitat in Spring Lake), and that salamanders are evenly distributed throughout available habitat at these densities, the number of San Marcos salamanders subject to incidental take as a result of the action can be estimated.

Given a density of 0.52 San Marcos salamanders per square foot (5.5 per square meter) within suitable habitat in the San Marcos River below Spring Lake dam, and the estimated 29,600 square feet (2,750 square meters) of suitable habitat at this location, the population at this location is estimated to total 15,457 individuals. A loss of 90% of suitable habitat would result in a total of 13,911 individual San Marcos salamanders subject to incidental take at this location during a DOR-like event. San Marcos salamander density within Spring Lake is estimated at 1.1 individuals per square foot (11.8 per square meter) of suitable habitat. Given approximately 332,500 square feet (30,890 square meters) of suitable habitat in Spring Lake, this yields an estimated population at this location of 365,750 individuals. Habitat losses of 60% would result in equivalent population losses of 219,450 San Marcos salamanders during a repeat of DOR-like conditions. The total number of San Marcos salamanders subject to incidental take during a repeat of DOR-like conditions, therefore, is 233,361 individuals.

We project that up to 10% of San Marcos salamander habitat could be affected by sediment removal, water-based recreation, non-native species management, and other considered activities in any year of average conditions; and that up to 10% of the San Marcos salamanders in the impacted areas may be displaced, injured, or killed as a result of these impacts.

Impacts to 10% of estimated 29,600 square feet (2,750 square meters) of suitable habitat in the uppermost San Marcos River result in a total of 2,960 square feet (275 square meters) of habitat impacts per year. If 10% of the San Marcos salamanders within the affected area are displaced, injured, or killed, a total of 154 salamanders would be subject to incidental take at this location per year. Within Spring Lake, impacts to10% of suitable San Marcos salamander habitat results in an estimated 33,250 square feet (3,089 square meters) of annual impact. If 10% of the salamanders within the affected areas are displaced, injured, or killed, a total of 3,658 individuals would be subject to incidental take at this location per year. The total number of San Marcos salamanders affected as a result of the action during these conditions totals 3,812 individuals per year. Over the eight-year projected duration of these conditions, a total of 30,496 salamanders could be subjected to incidental take.

The San Marcos salamander survived the historic DOR in Spring Lake and the San Marcos River, and the effects of the action include flow protection and springflow management measures that mimic historic conditions. The number of San Marcos salamanders subject to incidental take as a result of the action presuming a repeat of a seven-year DOR-like event and eight-years of additional impacts is up to an estimated 263,857 individuals. Because the species is known to have survived the historic event, and the HCP measures maintaining springflows and habitat conditions in Spring Lake are expected to maintain habitat conditions that meet or exceed those experienced during the DOR, the San Marcos salamander is expected to survive a repeat of DOR-like conditions as a result of implementing the HCP. Under the existing baseline conditions, springflow at San Marcos Springs would be expected to cease during DOR-like conditions. Because the species apparently survived the seven-year DOR event, and is expected to persist in Spring Lake even during a repeat of DOR-like conditions, we believe that this level of take resulting from implementation of the HCP will not appreciably reduce the likelihood of survival and recovery of the species in the wild.

Effects of the action on designated critical habitat

Designated critical habitat for the species consists of Spring Lake and the uppermost approximately 164 feet (50 meters) of the San Marcos River below Spring Lake dam (45 FR 47362).

Implementation of the measures described in the HCP will not affect water temperatures within the aquifer, and will therefore not affect springflow temperatures in Spring Lake or the uppermost San Marcos River. The effects of the action will not affect the ability of designated critical habitat to continue to provide water within normally observed temperature variances.

The action would result in implementation of the flow protection and springflow management measures that would maintain springflows at San Marcos Springs during drought conditions. None of the proposed HCP measures would destroy or modify the designated critical habitat from continuing to provide the flowing waters required for the conservation of the species.

The HCP includes proposed measures to reduce threats to water quality (as described above) that will reduce the probability of a spill or other release the San Marcos River and its tributaries, and decrease potential groundwater and surface water contamination. The effects of the action, therefore, will reduce the threat of water contamination and support the ability of the designated critical habitat to continue to provide high quality water with minimal levels of pollutants.

The effects of the action will result in implementation of HCP measures that will generate indirect adverse water quality impacts, such as turbidity associated with habitat restoration measures, targeted removal of non-native vegetation, and sediment removal within Spring Lake. In each case, however, these effects are anticipated to be short induration, and will not destroy or adversely modify the ability of designated critical habitat to continue to provide appropriate water quality.

Various HCP measures will also result in some disturbance of habitats and natural substrates. These measures include habitat restoration measures, targeted removal of non-native vegetation, and sediment removal activities. These effects are also anticipated to be experienced only while the measures are being implemented, and will not result in the destruction or adverse modification of the habitats or natural substrates required for the conservation of the San Marcos salamander.

xiii. Texas blind salamander

Effects of the action on the Texas blind salamander

The Texas blind salamander may be affected by implementation of flow protection and springflow management measures including changes to EAA CPM pumping restrictions, the management and use of the SAWS ASR to support springflows, implementation of the VISPO program or equivalent necessary measures, and reductions of surface water diversions from Spring Lake and the San Marcos River. During periods of average precipitation and recharge the indirect effects of regulation and production of groundwater and implementing these flow protection and springflow management measures will not affect aquifer levels or springflows at San Marcos Springs.

Decreased aquifer levels and loss of springflow are among the threats to the Texas blind salamander identified in the species' recovery plan (Service 1996a). The combined effect of the flow protection and springflow management measures during periods of drought and the increased aquifer levels generated by the RWC Program (as described above) will maintain increased water levels within the aquifer and provide for greater flows at San Marcos Springs and in the San Marcos River than would be expected under equivalent conditions today. The effect of the action under these conditions, therefore, will increase aquifer levels and San Marcos Springs flows over today's conditions.

The Texas blind salamander is also threatened by the potential loss of water quality. The HCP includes measures limiting the transport of hazardous materials across the San Marcos River and its tributaries. The HCP includes a commitment on the part of the City of San Marcos to implement a household hazardous waste program, a septic system registration and permitting program, impervious cover and water quality protection efforts, and contaminated runoff and stormwater minimization efforts. These measures will reduce threats to groundwater and surface water quality regardless of precipitation and recharge conditions. An indirect effect will be a resulting decrease in the species' potential exposure to contaminants that would not be expected today.

Because no quantitative data estimating population size of the Texas blind salamander is available, habitat impacts are relied on to estimate effects to the species that could constitute take. The HCP measures described above are anticipated to maintain aquifer levels and springflows generally supportive of the species' needs, though some drying of surface habitat near spring orifices that may affect the availability of food resources could occur during a repeat of DOR-like conditions. Under existing baseline conditions, aquifer levels are expected to drop to a level that would result in cessation of flow at San Marcos Springs. Because the species is believed to have survived the seven-year DOR event, and the effects of the action will maintain springflows at levels that mimic those historic conditions, we find that effects of the incidental taking resulting from implementation of the HCP will not appreciably reduce the likelihood of survival and recovery of the species in the wild.

Effects of the action on designated critical habitat

Critical habitat has not been designated for the Texas blind salamander; therefore, none will be impacted by the action.

xiv. Comal Springs salamander

Effects of the action on the Comal Springs salamander

Implementation of flow protection and springflow management measures that affect the Comal Springs salamander include changes to EAA CPM pumping restrictions, the management and use of the SAWS ASR to support springflows, and implementation of the VISPO program or equivalent necessary measures. During periods of average precipitation and recharge, the indirect effects of regulation and production of groundwater and implementing these flow protection and springflow management measures will not affect aquifer levels impacting springflows at Comal Springs.

The destruction, modification, or curtailment of habitat or range resulting from groundwater withdrawal is cited as a significant threat to the Comal Springs salamander, and ensuring increased flows during periods of drought may reduce the species' exposure to this effect. During drought conditions, the combined effect of the flow protection and springflow management measures and the increased aquifer levels generated by the RWC Program will maintain increased water levels within the aquifer and provide for greater springflows at Comal Springs than would be expected under equivalent conditions today. The effect of the action at Comal Springs, therefore, results in continual minimum springflows that exceed both historic and projected current flow rates under DOR-like conditions.

Groundwater contamination is also considered a threat to the species. The HCP includes proposed measures to protect and enhance water quality (as described above) that will decrease potential groundwater and surface water contamination and reduce threats to the Comal Springs salamander from exposure to these stressors over conditions found today. The effects of the action, therefore, will reduce the threat of water contamination and reduce the potential for the species to be exposed to these threats.

The effects of the action will support habitat for the Comal Springs salamander. Because no estimates of population size are available, we must rely on a conservative estimate of incidental take based on potential habitat impacts that may affect the species. Because the Comal Springs salamander is known only from the Comal Springs system, the species is presumed to have survived the historic DOR event, presumably by retreating into subsurface habitats within the springs and aquifer. The HCP measures described above are anticipated to maintain aquifer levels and springflows that exceed those experienced during the historic event, though drying of surface habitat near spring orifices that may affect feeding or sheltering during DOR-like conditions. As described above, under existing baseline conditions, aquifer levels are expected to drop to a level that would result in cessation of flow at Comal Springs. Because the species is believed to have survived the seven-year DOR event, and the effects of the action will maintain springflows at levels that mimic those historic conditions, we find that effects of the incidental taking occurring as a result of permit issuance will not appreciably reduce the likelihood of survival and recovery in the wild.

Effects of the action on designated critical habitat

The Comal Springs salamander is not currently listed as threatened or endangered, and therefore no critical habitat has been designated and none will be affected.

xv. Whooping Crane

Effects of the action on the Whooping Crane

The Applicants did not choose to include this species in the list of species for which they sought incidental take protection, and no such authorization is provided in the action.

The combined effect of the addition of Stage V CPM pumping restrictions, the management and use of the SAWS ASR, the VISPO program or equivalent necessary measures, and reductions of surface water diversions from Spring Lake and the San Marcos River in conjunction with demand reductions associated with the RWC program result in increases in springflows in the Comal and San Marcos Rivers during drought conditions, including those equivalent to the DOR.

At Comal Springs, the effect of the action during DOR-like conditions generates a continuous minimum total springflow of 27 cfs (0.76 cms) during Phase I and 30 cfs (0.85 cms) during HCP Phase II. These are comparable to the cessation of flow for four-months reported in 1956, and similar cessation for 38-months or 36-months under today's maximum allowable pumping and recent (2000 through 2010) average pumping projections, respectively. The effect of the action at Comal Springs, therefore, results in continual minimum springflows that exceeds both historic and projected current flow rates under DOR-like conditions.

The effects of the action to springflow at San Marcos during a repeat of DOR-like conditions result in a continuous minimum total springflow of 50.5 cfs (1.43 cms) during HCP Phase I and 51.2 cfs (1.45 cms) during Phase II, which are comparable to the historical flow of 54 cfs (1.5 cms) reported in 1956. By comparison, San Marcos Springs cease to flow under current conditions during both maximum permitted pumping and recent (2000 through 2010) average pumping projections. The effect of the action under these conditions, therefore, will increase flows from San Marcos Springs in Spring Lake and the San Marcos River over current baseline conditions.

The effect of the action during periods of drought will reduce the loss of aquifer levels and increase springflows that contribute to the instream flows of the Guadalupe River. Spring flows originating from the Edwards Aquifer are considered crucial for the Whooping Crane, especially in times of drought when they can make up 70 percent of Guadalupe River water. Freshwater inflows are essential to maintaining the productivity of coastal waters and producing foods used by whooping cranes. Coastal waters with low saline levels are maintained by these in-stream flows, providing drinking water for cranes that would otherwise expend additional energy to fly inland to locate drinking water sources.

Because Comal and San Marcos springflows flow into the Guadalupe River, and therefore contribute to the freshwater inputs vital to maintaining suitable wintering habitat for the Whooping Crane, the maintenance of springflows could reduce exposure to drought-related stressors and minimize the threat of these impacts over current baseline conditions. The effects of the action on the Whooping Crane, therefore, are anticipated to be wholly beneficial.

The effects of the action include the measures described above that reduce the potential for groundwater or surface water contamination. These measures will reduce these threats regardless of precipitation and recharge conditions. An indirect effect will be a resulting decrease in the species' potential exposure to contaminants when compared to baseline conditions.

Effects of the action on designated critical habitat

The anticipated instream flows during drought conditions resulting from implementation of the measures described in the conservation plan are expected to support the ability of the designated critical habitat to continue to provide the elements essential for the conservation of the Whooping Crane.

None of the measures proposed in the HCP that will result as direct or indirect effects of the action of issuing the permit will destroy or adversely modify any designated critical habitat for the Whooping Crane.

5. Cumulative Effects

Cumulative effects include the effects of future State, local, or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

The action area includes 17 counties and the duration of the proposed permit is 15-years. Because of this broad spatial extent and extended duration, exact identification of all present and reasonably foreseeable future activities is not feasible. However, identification of generalized activities and their impacts is possible and can be used to analyze their cumulative effect.

Therefore, the cumulative impacts assessment is not project specific or quantifiable, but provides an overview of present and reasonably foreseeable projects.

Transportation projects currently planned or under construction in the action area could generate effects in addition to those expected under the action. Locally funded non-Federal transportation projects such as county or municipal road projects could occur within the action area during the duration of the proposed permit. It is beyond the scope of this evaluation to analyze each of these transportation projects on an individual basis, but the effects of transportation projects are considered as for their potential to generate effects cumulative to the action.

Transportation projects over the contributing and recharge zones of the Edwards Aquifer could impact Aquifer recharge and thereby affect springflow. While the overall area affected by these projects represent a small percentage of the total action area, individual recharge sites that contribute significant recharge capacity can be affected by relatively small changes in surface contours, impervious surfaces, or vegetative cover. Alterations to recharge capacity or function could reduce inflows into the Edwards Aquifer and adversely impact springflows. The cumulative effects of reduced recharge capacity could result in further negative effects to springflows. Careful project design that identifies and avoids or provides adequate buffer zones around such recharge features throughout the study area can minimize the effects of these impacts.

Water infrastructure projects may have beneficial cumulative effects to Edwards Aquifer springflows. Projects that result in diversified water supplies or reduced demand for Edwards Aquifer water near Comal and San Marcos Springs may allow for increased Aquifer levels that would support springflows. Recharge enhancement structures within the contributing zone have been proposed to store surface water runoff for later release into the recharge zone. Proposed reservoirs within the recharge zone would impound surface water runoff to directly recharge the Edwards Aquifer. During periods of normal or high precipitation, these structures could provide some additional recharge that would support the Aquifer-fed springs. Such structures would only be expected to provide these benefits, however, when adequate precipitation provides surface flows to be impounded and stored for these uses. During DOR-like conditions, these structures are anticipated to be of little value to Edwards Aquifer recharge or springflow, and would be expected to have little cumulative effect to the considered action.

Reasonably foreseeable private and public land development activities could adversely affect springflows through various actions. Development that negatively affects recharge features through actions such as alteration of land contours or increasing impervious cover can result in reduced Edwards Aquifer inflows in much the same way as transportation projects. Development projects that generate additional demand for Edwards Aquifer water could reduce water volumes available for springflow.

Some natural resource management actions within the study area could provide cumulative effects benefitting springflows. Some reasonably foreseeable projects seek to ensure that recharge features continue to provide Edwards Aquifer inflows through voluntary conservation efforts or by way of municipal, county, or State-mandated regulatory measures. The efforts of non-governmental organizations (NGOs) such as the Bexar Land Trust, the Nature Conservancy, Texas Cave Management Association, and the Trust for Public Land, among others, to acquire or put legal mechanisms in place to conserve lands over the recharge and contributing zones have and are expected to continue to contribute to Edwards Aquifer recharge and springflows. Regulatory approaches such as existing City of San Antonio impervious cover limitations and TCEQ regulations regarding activities over the Edwards Aquifer further protect recharge and enhance springflows. Public education and outreach programs such as those employed by SAWS and the EAA that reduce demand for pumped Edwards Aquifer water also support increased springflows, though by an unquantifiable amount.

Reasonably foreseeable water quality within the study area is associated with population growth and effects may result from current or future actions within the study area. Projected population growth throughout the region is expected to result in greater urbanization and includes ongoing or planned transportation, water supply, and other development projects that may affect water quality. Urban and suburban development can increase the risk of water quality degradation associated with point and non-point source pollution.

Some groundwater quality effects are the result of reasonably foreseeable transportation, water supply, and land development actions. Existing and ongoing development in some San Antonio, New Braunfels and San Marcos watersheds have the potential to directly affect the quality of recharge waters that could impact groundwater by increasing impervious cover, stormwater runoff, and other non-point source impacts associated with increasing development density. Ongoing and future development associated with projected population growth could be reasonably expected to contribute to additional water quality impacts.

6. Biological Opinion Conclusion

After reviewing the current status of Texas wild-rice, Golden orb, Texas pimpleback, Texas fatmucket, Comal Springs dryopid beetle, Comal Springs riffle beetle, Texas cave diving beetle, Texas troglobitic water slater, Peck's cave amphipod, fountain darter, San Marcos gambusia, San Marcos salamander, Texas blind salamander, Comal Springs salamander, and the Whooping Crane; designated critical habitat; the environmental baseline; the effects of the action; and the cumulative effects, it is the Service's biological opinion that issuance of the ITP, supported by the EARIP HCP, is not likely to jeopardize the continued existence of these species or destroy or adversely modify designated critical habitat for Texas wild-rice, Comal Springs dryopid beetle, Comal Springs riffle beetle, Peck's cave amphipod, fountain darter, San Marcos gambusia, San Marcos salamander, or the Whooping Crane.

7. Conference Opinion on Proposed Revisions to Designated Critical Habitat

As described above, a settlement agreement among the Service, the Center for Biological Diversity, Citizens Alliance for Smart Expansion, and Aquifer Guardians in Urban Areas, was filed on December 18, 2009, in which the Service agreed to submit to the Federal Register a revised proposed rule for designation of critical habitat for the Comal Springs dryopid beetle, the Comal Spring riffle beetle, and the Peck's cave amphipod on or before October 17, 2012, and a final rule for critical habitat on or before October 13, 2013. A proposed rule was published in the Federal Register in accordance with the settlement agreement, and public review and comment have been solicited (77 FR 64272).

The following Conference Opinion is limited to an analysis of effects of the action on the proposed revision to the critical habitat designation for each of these three species.

The following description of proposed PCEs has been excerpted from the proposed Revision of Critical Habitat for the Comal Springs Dryopid Beetle, Comal Springs Riffle Beetle, and Peck's Cave Amphipod (77 FR 64272). The proposed designations of critical habitat are provided for each of the species, below.

"Based on our current knowledge of the physical or biological features and habitat characteristics required to sustain the species' life-history processes, we determine that the primary constituent elements specific to the Comal Springs dryopid beetle, Comal Springs riffle beetle, and Peck's cave amphipod are:

> (1) Springs, associated streams, and underground spaces immediately inside of or adjacent to springs, seeps, and upwellings that include:
>> (a) High-quality water with no or minimal pollutant levels of soaps, detergents, heavy metals, pesticides, fertilizer nutrients, petroleum hydrocarbons, and semi-volatile compounds such as industrial cleaning agents; and
>> (b) Hydrologic regimes similar to the historical pattern of the specific sites must be present, with continuous surface flow from the spring sites and in the subterranean aquifer.
>
> (2) Spring system water temperatures that range from 68 to 75°F (20 to 23.4°C).
> (3) Food supply that includes, but is not limited to, detritus (decomposed materials), leaf litter, living plant material, algae, fungi, bacteria, other microorganisms, and decaying roots."

Effects of the action on the proposed revision to designated critical habitat for the Comal Springs dryopid beetle

The proposed revision to designated critical habitat for the Comal Springs dryopid beetle (77 FR 64272) States, in part:

> "We identified both surface and subsurface components of critical habitat for this species, which has been found in Comal Springs and Fern Bank Springs in Comal and Hays Counties, Texas. However, this species was recently collected from Panther Canyon Well, located about 360 foot away from the spring outlet of Spring Run No. 1 (Barr and Spangler 1992, Gibson 2012e, pers. comm.). Collections made from 2003 to 2009 further extended the known range of the beetle within the Comal Springs system to all major spring runs, seeps along the western shoreline of Landa Lake (the impounded portion of the Comal Springs system), Landa Lake upwellings in the Spring Island area, and Panther Canyon Well (Bio-West, Inc. 2003, 2004, 2005, 2006, 2009, R. Gibson 2012e, pers. comm.). This information indicates that the Comal Springs dryopid beetle can travel through the aquifer up to a distance of 360 feet; therefore, we used this distance from spring outlets to identify the subsurface area of critical habitat for this species.
>
> To determine surface critical habitat, we used an area consisting of a 50-foot (15.2 meter) distance from spring outlets. We used this area because this distance has been found to

> contain food sources where plant roots interface with water flows of the spring systems. This 50-foot distance defines the lateral extent of surface critical habitat that contains elements necessary to provide for life functions of this species with respect to roots that can penetrate into the aquifer. The 50-foot (15.2 meter) distance was calculated from evaluations of aerial photographs and is based on tree and shrub canopies occurring in proximity to spring outlets. Extent of canopy cover reflects the approximate distances where plant root systems interface with water flows of the two spring systems."

The effect of the action includes implementation of measures to reduce threats to water quality (as described above) that will decrease potential groundwater and surface water contamination and reduce threats to the species from exposure to these stressors over baseline conditions. The effects of the action, therefore, will reduce the threat of water contamination and contribute to the ability of the designated critical habitat to continue to provide high-quality water with no or minimal pollutant levels of soaps, detergents, heavy metals, pesticides, fertilizer nutrients, petroleum hydrocarbons, and semi-volatile compounds such as industrial cleaning agents.

Implementation of the measures proposed in the HCP will not affect water temperatures within the aquifer, and will therefore not affect springflow temperatures at Comal Springs. The effects of the action will not affect the ability of this designated critical habitat unit from continuing to provide this primary constituent element.

The action would result in implementation of the flow protection and springflow management measures described above. During periods of average precipitation and recharge the implementation of these measures will not affect aquifer levels impacting springflows at Comal Springs. The resulting effects of the action to designated critical habitat for the Comal Springs dryopid beetle during average precipitation and recharge conditions are discountable. During drought conditions the combined effects of these measures will maintain springflows at Comal Springs, thereby supporting the capacity of the designated critical habitat to provide flowing water and a hydrologic regime that supports the defined water quality parameters.

Riparian restoration measures may impact designated critical habitat at Comal Springs through substrate disturbance and increased turbidity. The short term adverse substrate and water quality impacts anticipated to occur while these activities are implemented, as well as the improved long-term capacity of restored habitat areas to provide food supplies required by the Comal Springs dryopid beetle described as a primary constituent element, are also effects of the action.

The hydrology at Fern Bank Springs is poorly understood, and multiple sources of the springwater at this location have been proposed (USFWS 1996a). Recent evidence suggests that the water at Fern Bank Springs may be sourced from areas south of the Blanco River (EAA 2010). If completely sourced from the Edwards Aquifer, implementation of the proposed measures described above would not be expected to prevent the designated critical habitat unit at this site from continuing to provide food supplies and appropriate water quality requirements described as primary constituents necessary for the conservation of the species. If Fern Bank Springs is only partially sourced from the Edwards Aquifer, or if all Fern Bank Springs water is derived from other sources, the HCP measures considered would also not prevent this location from continuing to provide these elements.

None of the measures proposed in the EARIP HCP will destroy or adversely modify the ability of the proposed Comal Springs dryopid beetle revised designated critical habitat from providing the identified primary constituent elements required for the conservation of the species.

Effects of the action on the proposed revision to designated critical habitat for the Comal Springs riffle beetle

The proposed revision to designated critical habitat for the Comal Springs dryopid beetle (77 FR 64272) states, in part:

> "For the Comal Springs riffle beetle, we only identified surface critical habitat because this species' habitat is primarily restricted to surface water, which is located in two impounded spring systems in Comal and Hays Counties, Texas. In Comal County, this aquatic beetle is found in various spring outlets of Comal Springs that occur within Landa Lake over a linear distance of approximately 0.9 mi (1.4 km). The species has also been found in outlets of San Marcos Springs in the upstream portion of Spring Lake in Hays County. However, populations of Comal Springs riffle beetles may exist elsewhere in Spring Lake (excluding a slough portion that lacks spring outlets), but sampling for riffle beetles at spring outlets within the lake has only been done on a limited basis. Excluding the slough portion that lacks spring outlets, the approximate linear distance of Spring Lake at its greatest length is 0.2 mi (0.3 km). Critical habitat unit boundaries for surface area were delineated using the same criteria as described above for the Comal Springs dryopid beetle."

The effect of the action includes measures to reduce threats to water quality (as described above) that will decrease potential groundwater and surface water contamination and reduce threats to the species from exposure to these stressors over baseline conditions. The effects of the action, therefore, will reduce the threat of water contamination and contribute to the ability of designated critical habitat units to continue to provide high quality water with minimal levels of pollutants described as a constituent element necessary for the conservation of the species.

Implementation of the measures in the HCP will not affect water temperatures within the aquifer, and will therefore not affect springflow temperatures at Comal or San Marcos Springs. The effects of the action will not affect the ability of designated critical habitat units from continuing to provide this primary constituent element.

The action would result in implementation of the flow protection and springflow management measures described above. During drought conditions the combined effects of these measures will maintain springflows at Comal and San Marcos Springs, thereby supporting the capacity of the designated critical habitat to provide flowing water and a hydrologic regime able to support the defined water quality parameters.

Riparian restoration measures may impact designated critical habitat through substrate disturbance and increased turbidity. The short term substrate and water quality impacts anticipated to occur while these activities are implemented, as well as the improved capacity of restored habitat areas to provide food supplies required by the Comal Springs dryopid beetle described as a primary constituent element, are also effects of the action.

Sediment removal measures at San Marcos Springs are intended to remove interstitial sedimentation and return Spring Lake substrates to a more natural condition to ensure that the designated critical habitat continues to provide the constituent element requiring gravel and cobble substrates that are free of sand and silt.

The effects of the action will not destroy or adversely modify the ability of the revised designated critical habitat of the Comal Springs riffle beetle from providing the identified primary constituent elements required for the conservation of the species.

Effects of the action on the proposed revision to designated critical habitat for Peck's cave amphipod

The proposed revision to designated critical habitat for Peck's cave amphipod (77 FR 64272) States, in part:

> "We identified both surface and subsurface components of critical habitat for this species, which has been found in Comal Springs and Hueco Springs, both located in Comal County, Texas. The extent to which this subterranean species exists below ground away from spring outlets is unknown; however, other species within the genus *Stygobromus* are widely distributed in groundwater and cave systems (Holsinger 1972). Like the Comal Springs dryopid beetle, the Peck's cave amphipod has been collected from the bottom of Panther Canyon Well, which is located about 360 feet (110 meters) away from the spring outlet of Spring Run # 1 in the Comal Springs complex (Barr and Spangler 1992, Gibson *et al.* 2008).
>
> To determine surface critical habitat, we used a 50-foot (15.2 meter) distance from the shoreline of both Comal Springs and Hueco Springs (including several satellite springs that are located between the main outlet of Hueco Springs and the Guadalupe River) to include amphipod food sources in the root-water interfaces around spring outlets. Critical habitat unit boundaries were delineated using the same criteria as described above for the other two invertebrate species."

The effect of the action includes measures that will reduce threats to water quality (as described above), decrease potential groundwater and surface water contamination, and reduce threats to the species from exposure to these stressors over baseline conditions. The effects of the action, therefore, will reduce the threat of water contamination and contribute to the ability of the designated critical habitat unit at Comal Springs to continue to provide high quality water with minimal levels of pollutants.

Implementation of the measures proposed in the HCP will not affect water temperatures within the aquifer, and will therefore not affect springflow temperatures. The effects of the action will not affect designated critical habitat from continuing to provide this primary constituent element.

The action would result in implementation of the flow protection and springflow management measures described above. During drought conditions the combined effects of these measures will maintain springflows at Comal Springs, thereby supporting the capacity of the designated critical habitat to provide flowing water and a hydrologic regime that supports the defined water quality parameters. These measures will increase aquifer levels that may provide some support for continued springflows at Hueco Springs, though no data is available to assess the certainty and magnitude of this potential effect.

Riparian restoration measures may impact designated critical habitat at Comal Springs through substrate disturbance and increased turbidity. The short term substrate and water quality impacts anticipated to occur while these activities are implemented, as well as the improved capacity of restored habitat areas to provide food supplies required by Peck's cave amphipod described as a primary constituent element, are also effects of the action.

The effects of the action will not destroy or adversely modify the ability of the revised designated critical habitat of the Comal Springs riffle beetle from providing the identified primary constituent elements required for the conservation of the species.

Conference Opinion Conclusion

After reviewing the current status of the Comal Springs dryopid beetle, Comal Springs riffle beetle, and Peck's cave amphipod, the environmental baseline for the action area, the effects of the actions and the cumulative effects, it is the Service's Conference Opinion that the issuance of a section 10(a)(1)(B) permit for the incidental take of listed species resulting from the Applicants' otherwise lawful non-Federal activities including the regulation and production of groundwater in accordance with State law for irrigation, industrial, municipal, domestic, and livestock purposes; the use of the Comal River and San Marcos River for recreational uses; operational and maintenance activities that could affect Comal Springs, San Marcos Springs, and the associated river systems; and activities necessary to manage potential habitat for the covered species within the permit area; is not likely destroy or adversely modify the proposed revised critical habitat for the Comal Springs dryopid beetle, the Comal Springs riffle beetle, or the Peck's cave amphipod.

This concludes the conference for issuance of a section 10(a)(1)(B) permit for the incidental take of listed species resulting from the Applicants' otherwise lawful non-Federal activities including the regulation and production of groundwater in accordance with State law for irrigation, industrial, municipal, domestic, and livestock purposes; the use of the Comal River and San Marcos River for recreational uses; operational and maintenance activities that could affect Comal Springs, San Marcos Springs, and the associated river systems; and activities necessary to manage potential habitat for the covered species within the permit area.

After revision of designated critical habitat for the Comal Springs dryopid beetle, the Comal Springs riffle beetle, or the Peck's cave amphipod and any subsequent adoption of this conference opinion, the Service shall request reinitiation of consultation if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect species or critical habitat in a manner or to an extent not considered in this conference opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the species or critical habitat that was not considered in this conference opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action.

The incidental take Statement provided in this conference opinion does not become effective until the proposed revisions to critical habitat are designated and the conference opinion is adopted as the biological opinion issued through formal consultation. At that time, the project will be reviewed to determine whether any take of the habitat has occurred. Modifications of the opinion and incidental take Statement may be appropriate to reflect that take. No take of the habitat may occur between the designation of critical habitat and the adoption of the conference opinion through formal consultation, or the completion of a subsequent formal consultation.

8. INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulations pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined by the Service as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harass is further defined by the Service as an intentional or negligent act or omission which creates the likelihood of injury to a listed species by annoying it to such an extent as to significantly disrupt normal behavioral patterns, which include, but are not limited to, breeding, feeding and sheltering (50 CFR §17.3). Harm is also further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by impairing behavioral patterns, including breeding, feeding, and sheltering. Incidental take is defined by the Service as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act, provided that such taking is in compliance with this Incidental Take Statement.

The EARIP HCP and its associated documents clearly identify anticipated impacts to affected species likely to result from the proposed taking and the measures that are necessary and appropriate to minimize these impacts. All conservation measures described in the proposed HCP, together with the terms and conditions described in any associated Implementing Agreement and any Section 10(a)(1)(B) permit or permits issued with respect to the HCP are hereby incorporated by reference as reasonable and prudent measures and terms and conditions within this Incidental Take Statement pursuant to 50 CFR §402.14(i). Such terms and conditions are non-discretionary and must be undertaken for the exemptions under section 10(a)(1)(B) and section 7(o)(2) of the Act to apply. If the permittees fail to adhere to these terms and conditions, the protective coverage of the section 10(a)(1)(B) permit and section 7(o)(2) may lapse. The amount or extent of incidental take anticipated under the EARIP HCP, associated reporting requirements, and provisions for disposition of dead or injured animals are as described in the HCP and its accompanying section 10(a)(1)(B) permit.

Sections 7(b)(4) and 7(o)(2) of the Act generally do not apply to listed species. However, limited protection of listed plants from take is provided to the extent that the Act prohibits the removal and reduction to possession of Federally listed endangered plants or the malicious damage of such plants on areas under Federal jurisdiction, or the destruction of endangered plants on non-Federal areas in violation of State law or regulation or in the course of any violation of a State criminal trespass law.

Amount or Extent of Take

The Service anticipates incidental take of Comal Springs dryopid beetle, Comal Springs riffle beetle, Texas cave diving beetle, Texas troglobitic water slater, Peck's cave amphipod, fountain darter, San Marcos gambusia, San Marcos salamander, Texas blind salamander, and Comal Springs salamander will occur as a result of the action. Quantifying the impacts to and take of individuals is confounded by the aquatic nature of many of the species considered here. Effects of the action that might include reduction in springflow, for example, are likely to result in harm or harassment through displacement rather than in injury or death of individuals. Actual numbers of individuals that may be injured or killed may not be known because in some cases we lack the ability to effectively survey the subterranean aquatic habitats some of these species occupy, and the small size of some species and the soft and quickly decomposed bodies of others make detection of injured or dead individuals uncertain even under ideal field sampling conditions. For the species considered here, incidental take, from covered activities are expected to occur in the form of harm and harassment through direct loss of habitat and adverse effects resulting from the issuance of an incidental take permit under Section 10(a)(1)(B) of the Act.

The following amount of incidental take will be authorized by the permit:

1. No more than 1,543 Comal Springs dryopid beetles.
2. No more than 11,179 Comal Springs riffle beetles.
3. Incidental take of the Texas cave diving beetle will be provided for individuals of the species killed, harmed, or harassed by continuous springflows as low as 50.5 cfs (1.43 cms) and/or up to 30 days below 50 cfs (1.4 cms) during HCP Phase I and by continuous springflows to 51.2 cfs (1.45 cms) and/or up to15 days below 50 cfs (1.4 cms) during Phase II at San Marcos Springs. Take limits will be exceeded if these minimum flow rates and/or durations are exceeded.
4. Incidental take of the Texas troglobitic water slater will be provided for individuals of the species killed, harmed, or harassed by continuous springflows as low as 50.5 cfs (1.43 cms) and/or up to 30 days below 50 cfs (1.4 cms) during HCP Phase I and by continuous springflows to 51.2 cfs (1.45 cms) and/or up to15 days below 50 cfs (1.4 cms) during Phase II at San Marcos Springs. Take limits will be exceeded if these minimum flow rates and/or durations are exceeded.
5. No more than 18,224 Peck's cave amphipod.
6. No more than 797,000 fountain darters in Comal Springs, Landa Lake and the Comal River, and no more than 549,129 fountain darters in the San Marcos Springs, Spring Lake, and San Marcos River.
7. It is our intent to provide incidental take coverage for the covered activities described above for the San Marcos gambusia if the species is determined to continue to exist in the wild.
8. No more than 263,857 San Marcos salamanders.
9. No more than 10 Texas Blind salamanders.
10. Incidental take of the Comal Springs salamander will be provided for individuals of the species killed, harmed, or harassed by continuous springflows as low as 27 cfs (0.76 cms)

and/or up to 75 days below 30 cfs (0.85 cms) during HCP Phase I and by continuous springflows to 45 cfs (1.27 cms) and/or up to30 days below 45 cfs (1.27 cms) during Phase II at Comal Springs. Take limits will be exceeded if these minimum flow rates and/or durations are exceeded.

Effect of the Take

In the accompanying biological opinion, the Service has determined that this level of anticipated take is not likely to jeopardize Texas wild-rice, Comal Springs dryopid beetle, Comal Springs riffle beetle, Texas cave diving beetle, Texas troglobitic water slater, Peck's cave amphipod, fountain darter, San Marcos salamander, Texas blind salamander, Comal Springs salamander, or the Whooping Crane for the reasons Stated above. It has also been determined that designated critical habitat for Texas wild-rice, Comal Springs dryopid beetle, Comal Springs riffle beetle, Peck's cave amphipod, fountain darter, San Marcos gambusia, San Marcos salamander, and the Whooping Crane that may be affected by the action will not be destroyed or adversely modified.

a. Reasonable and Prudent Measures

The Service believes the following reasonable and prudent measures are necessary and appropriate to minimize incidental take of covered species. The Service shall:

1. Require the Applicant to fully implement the EARIP HCP and comply with all terms and conditions of the issued section 10(a)(1)(B) incidental take permit; and,
2. Require the Applicants to avoid disturbance of the (a) substrate, (b) water quality, (c) plants, and (d) animals of the Comal Springs, Landa Lake, and Comal River in the course of implementing HCP measures when possible and reduced to the maximum extent practicable where disturbance is unavoidable; and,
3. Require the Applicants to avoid disturbance of the (a) substrate, (b) water quality, (c) plants, and (d) animals of the San Marcos Springs, Spring Lake, and the San Marcos River in the course of implementing HCP measures when possible and reduced to the maximum extent practicable where disturbance is unavoidable.

b. Terms and Conditions

To be exempt from the prohibitions of section 9 of the Act, the Service must ensure compliance with the following terms and conditions, which implement the reasonable and prudent measures, described above and outline required reporting and monitoring requirements. The Applicants shall be responsible for complying with these terms and conditions, which are non-discretionary.

Terms and conditions that implement RPM No. 1:

1. The authorization granted by this permit is subject to compliance with all terms and conditions contained in the permit.
2. Ensure that the Applicants avoid and minimize incidental take of the Covered Species, in the form of death, harm, or harassment, by fully implementing the *EARIP Habitat Conservation Plan* dated November 2012; and
3. Ensure that the Applicants fully mitigate the effects of the taking of the Covered Species

from Covered Activities, as described in the *EARIP Habitat Conservation Plan* dated November 2012.

Terms and conditions that implement RPM No. 2:

1. Require the Applicants to limit disturbance of the (a) substrate, (b) water quality, (c) plants, and (d) animals of the Comal Springs, Landa Lake, and Comal River to no more than 10% of the occupied habitat on an annual basis when implementing HCP measures such as habitat and riparian restoration efforts that may directly or indirectly affect species considered here; and,

2. Require the Applicants to suspend activities such as habitat restoration and riparian restoration that may result in disturbance of the (a) substrate, (b) water quality, (c) plants, and (d) animals of the Comal Springs, Landa Lake, and the Comal River when Comal Springflows decline to 130 cfs (3.7 cms) or lower.

Terms and conditions that implement RPM No. 3:

1. Require the Applicants to limit disturbance of the (a) substrate, (b) water quality, (c) plants, and (d) animals of the San Marcos Springs, Spring Lake, and the San Marcos River to no more than 10% of the occupied habitat on an annual basis when implementing HCP measures such as habitat and riparian restoration efforts that may directly or indirectly affect species considered here; and,

2. Require the Applicants to suspend activities such as habitat restoration and riparian restoration that may result in disturbance of the (a) substrate, (b) water quality, (c) plants, and (d) animals of the San Marcos Springs, Spring Lake, and the San Marcos River when San Marcos Springflows decline to 120 cfs (3.4 cms) or lower.

Permit terms and conditions:

A. Acceptance of the permit serves as evidence that the Permittees (the EARIP) agree to abide by all conditions stated. Terms and conditions of the permit are inclusive. Any activity not specifically permitted is prohibited. Please read through these conditions carefully as violations of permit terms and conditions could result in your permit being suspended or revoked. Violations of your permit terms and conditions that contribute to a violation of the Endangered Species Act (ESA or Act) could also subject the Permittee to criminal or civil penalties.

B. The authorization granted by this Permit will be subject to full and complete compliance with, and implementation of, the EARIP HCP, and all specific conditions contained herein. The Permit terms and conditions shall supersede and take precedence over any inconsistent provisions in the HCP or other program documents.

C. This permit does not include incidental take coverage for any federal facility which withdraws groundwater from the Edwards Aquifer.

D. This permit only authorizes incidental take of animal species, or impacts to plant species of the following 11 species (covered species):

Common Name	**Scientific Name**	**ESA Status**
Fountain Darter	*Etheostoma fonticola*	Endangered
San Marcos Gambusia	*Gambusia georgei*	Endangered
Comal Springs Dryopid Beetle	*Stygoparnus comalensis*	Endangered
Comal Springs Riffle Beetle	*Heterelmis comalensis*	Endangered
Peck's Cave Amphipod	*Stygobromus pecki*	Endangered
Texas Wild Rice	*Zizania texana*	Endangered
Texas Blind Salamander	*Eurycea* (=*Typhlomolge*) *rathbuni*	Endangered
San Marcos Salamander	*Eurycea nana*	Threatened
Texas cave diving beetle	*Haideoporus texanus*	Petitioned
Comal Springs Salamander	*Eurycea sp.*	Petitioned
Texas Troglobitic Water Slater	*Lirceolus smithii*	Petitioned

E. Incidental take authorized by this permit for a 15 year period:

1. No more than 797,000 fountain darters in Comal Springs, Landa Lake and the Comal River, and no more than 549,129 fountain darters in the San Marcos Springs, Spring Lake, and San Marcos River.
2. No more than 11,179 Comal Springs riffle beetles.
3. No more than 1,543 Comal Springs dryopid beetles.
4. No more than 18,224 Peck's cave amphipod.
5. No more than 10 Texas Blind salamanders.
6. No more than 263,857 San Marcos salamanders.
7. Incidental take of the Texas cave diving beetle will be provided for individuals of the species killed, harmed, or harassed by springflows with monthly averages above 50.5 cfs (1.43 cms) during HCP Phase I; and by springflows with monthly averages above 51.2 cfs (1.45 cms) during Phase II at San Marcos Springs if and when this species is listed as threatened or endangered so long as the HCP is fully implemented. Take limits will be exceeded if these minimum flow rates are exceeded.
8. Incidental take of the Texas troglobitic water slater will be provided for individuals of the species killed, harmed, or harassed by springflows with monthly averages above 50.5 cfs (1.43 cms) during HCP Phase I; and by springflows with monthly averages above 51.2

cfs (1.45 cms) during Phase II at San Marcos Springs if and when this species is listed as threatened or endangered so long as the HCP is fully implemented. Take limits will be exceeded if these minimum flow rates are exceeded.

9. Incidental take of the Comal Springs salamander will be provided for individuals of the species killed, harmed, or harassed by springflows with monthly averages above 27 cfs (0.76 cms) during HCP Phase I and by continuous springflows to 45 cfs (1.27 cms) during Phase II at Comal Springs if and when this species is listed as threatened or endangered so long as the HCP is fully implemented. Take limits will be exceeded if these minimum flow rates are exceeded.

F. The endangered San Marcos gambusia (*Gambusia georgei*) has not been collected since 1982 and may no longer exist in the wild, but the Service will provide incidental take coverage for individuals of this species resulting from the covered activities if the species is located or becomes established within the Permit Area so long as the HCP is fully implemented.

G. This permit only authorizes incidental take of covered species within all of Bexar, Medina, and Uvalde counties, and parts of Atascosa, Comal, Caldwell, Hays, and Guadalupe counties (Permit Area).

H. The EAA will support and coordinate with the U.S. Fish and Wildlife Service (Service) on the work relating to the San Marcos Aquatic Resource Center's operation and maintenance of a series of off-site refugia at the Service's San Marcos, Uvalde, and Inks Dam facilities (Section 6.4 of the HCP). The support of the refugia will augment the existing financial and physical resources of these facilities, and provide supplementary resources for appropriate research activities, as necessary, to house and protect adequate populations of Covered Species and expanded knowledge of their biology, life histories, and effective reintroduction techniques. The use of this support will be limited to the Covered Species in the EARIP HCP.

I. Incidental Take Authorization

1. Edwards Aquifer Authority (EAA) – Covered activities for which incidental take is authorized:

   a. Programs that implement the statutory functions of the EAA Act, including:

      1. Authorization of withdrawals by persons who are both authorized under the EAA Act and the EAA's rules to withdraw groundwater from the Edwards Aquifer within the jurisdictional boundaries of the EAA.

      2. Authorization of withdrawals from the Edwards Aquifer pursuant to a change in permit under the EAA's permit administration rules in subchapter L of Chapter 711 and for owners and lessees making withdrawals under such a change in permit.
      3. Withdrawals due to the authorization of a "conversion" of "base" water into "unrestricted" water (EAA Rules §§ 711.338-.342) from the irrigator installing

water conservation equipment such that less water is required for irrigation of the historically irrigated land (EAA Act § 1.34(b)) or when the historically irrigated lands that provided the basis for the issuance of the Initial Regular Permit have been developed and are no longer farmed under the circumstances described in the EAA rules.

4. Withdrawals from the Edwards Aquifer pursuant to the Critical Period Management plan described in Section 5.1.4 of the HCP.

b. The minimization and mitigation measures that the EAA either will implement or for which it bears responsibility for having implemented as identified in Chapter 5 of the HCP include:

1. Voluntary Irrigation Suspension Program Option (Section 5.1.2).
2. Regional Water Conservation Program (Section 5.1.3).
3. Critical Period Management – a Stage V (Section 5.1.4).
4. Expanded Water Quality Monitoring (Section 5.7.5).
5. Impervious cover/water quality protection (Section 5.7.6)

2. City of New Braunfels – Covered activities for which incidental take is authorized:

g. Recreational activities within the City of New Braunfels's jurisdiction that are facilitated in any respect by the City of New Braunfels, including but not limited to swimming, wading, tubing, boating, canoeing, kayaking, scuba diving, snorkeling, and fishing, in accordance with all applicable laws and regulations (Section 2.3.1 of the HCP).

1. The City of New Braunfels will limit recreational access to the spring runs to the Wading Pool in Spring Run 2; and prohibit recreation within the old channel with the exception of Schlitterbahn operations within its present location (Section 5.2.3 of the HCP).
2. Where recreation is facilitated by commercial outfitting businesses, the City of New Braunfels will extend their incidental take coverage to participating businesses through Certificates of Inclusion (Section 5.2.3 of the HCP).

h. Management of the ecosystems of the Comal Springs, Landa Lake, and Comal River. The City operates gates, culverts, and dam structures from Landa Lake to the Old Channel (three culverts), New Channel U.S. Geological Survey (USGS) Weir, Springfed Pool Inlet, Wading Pool Weir, Clemens Dam, USGS Weir (known as "Stinky Falls"), Golf Course Weir, and Mill Pond Dam (joint New Braunfels Utility and City of New Braunfels operation) to maintain constant flow in the Comal River, maintain constant elevations of large pools, and regulate flow regimes in the old and new channels during high and low flow events (Sections 2.3.2 and 2.3.3 of the HCP).

i. Diversion of water from the Comal River in accordance with State law. The City of New Braunfels is authorized to divert 8 acre feet per year (9,868 cubic meters per year) of water from the Old Channel and impound it in the pool by TCEQ Permit 18-

3826 as a non-consumptive use because the water is returned to the Old Channel (Section 2.3.4 of the HCP).

j. Maintenance and operation of the spring-fed pool (including routine cleaning, algae removal, chemical application pursuant to label instructions, and filling/emptying) in accordance with the HCP (Section 2.3.4 of the HCP).

k. The City of New Braunfels operation of boats on the Comal River and Landa Lake for research, enforcement, litter collection, and maintenance activities (section 2.3.5 of the HCP).

l. The minimization and mitigation measures that the City of New Braunfels will either implement or have responsibility for having implemented as identified in Chapter 5 of the HCP include:

1. Management of river flow between old and new channels of the Comal River (Section 5.2.1)
2. Restoration and maintenance of native aquatic vegetation (Section 5.2.2)
3. Management of public recreational use of Comal Springs and the Comal River (Section 5.2.3)
4. Removal of decaying vegetation and dissolved oxygen management (Section 5.2.4)
5. Management of harmful non-native animal species (Sections 5.2.5 and 5.2.9)
6. Monitoring and management of the non-native introduced trematode *Centrocestus formosanus* that parasitizes the fountain darter (Sections 5.2.6 and 6.3.6 of the HCP).
7. Prohibition of hazardous materials transport across the Comal River and its tributaries (Section 5.2.7)
8. Restoration of native riparian vegetation (Section 5.2.8 and 5.7.1)
9. Reduction of non-native species introduction and live bait prohibitions (Section 5.2.9)
10. Litter Collection and Floating Vegetation Management (Section 5.2.10)
11. Management of Golf Course Diversions and Operations (5.2.11)
12. Management of Household Hazardous Wastes (Section 5.7.5)
13. Impervious Cover/Water Quality Protection (Section 5.7.6)
14. Removal of sediment (Section 5.2.2.1)

3. City of San Marcos – Covered activities for which incidental take is authorized:

f. Recreational activities within the City of San Marcos's jurisdiction, including, but not limited to, swimming, wading, tubing, boating, canoeing, kayaking, golfing, snorkeling, SCUBA diving, and fishing, in accordance with all applicable laws and regulations (Section 2.4.of the HCP).

1. Establishment of permanent access points for recreation and closure of unauthorized access points (Sections 5.3.2 and 5.3.7 of the HCP).
2. Where recreation is facilitated by commercial outfitting businesses, the City of San Marcos will extend their incidental take coverage to participating businesses through Certificates of Inclusion (Section 5.3.2.1 of the HCP).

3. The City of San Marcos will enforce trespassing laws to prevent the public from accessing the river via private property, without property owner's permission (Section 5.3.2.1 of the HCP).
4. The City of San Marcos will create an appropriate buffer zone by location to keep picnic tables, pop-up tents, shelters, and portable grills away from the river to reduce litter in the river and decrease bank compaction and /or erosion (Section 5.3.2.1 of the HCP).
5. The City of San Marcos will educate river users and the community about applicable regulations and the importance of protecting the area's natural resources (section 5.3.2.1 of the HCP).

g. The City of San Marcos operation of boats on the San Marcos River and Spring Lake for research, enforcement, litter collection, and maintenance activities (section 2.4.2 of the HCP). Only electric trolling motors are permitted and no gasoline or petroleum fueled boats are allowed on Spring Lake.

h. Routine, minor repairs of infrastructure and facilities associated with or located on City of San Marcos property that are adjacent to or directly affect the San Marcos Springs and River ecosystem (Section 2.4.3 of the HCP). Routine, minor repairs would include activities such as repairs to access points along the river, but would not involve any activity requiring a U.S. Army Corps of Engineers (USACE) § 404 permit or authorization which may require a section 7 consultation by the USACE.

i. The mitigation and minimization measures that the City of San Marcos will either implement or have the responsibility of implementing as identified in Chapter 5 of the HCP include:

1. Enhancement and restoration Texas Wild-rice (Section 5.3.1 of the HCP)
2. Management of public recreation at San Marcos Springs and the San Marcos River (Section 5.3.2 of the HCP)
3. Management of aquatic vegetation and litter below Sewell Park (Section 5.3.3)
4. Prohibition of hazardous materials transport across the San Marcos River and its tributaries (Section 5.3.4 of the HCP)
5. Reduction of non-native species introduction (Section 5.3.5 of the HCP)
6. Removal of harmful erosion-related sediment below Sewell Park (Section 5.3.6 of the HCP)
7. Designation of permanent access points and bank stabilization (Section 5.3.7 of the HCP)
8. Management of non-native plant species (Section 5.3.8 of the HCP)
9. Management of harmful non-native and predator species (Section 5.3.9 of the HCP)
10. Restoration of native riparian vegetation (Section 5.7.1 of the HCP)
11. Implementation of a City of San Marcos septic system registration and permitting program (Section 5.7.3 of the HCP)
12. Management of potentially contaminated runoff (Section 5.7.4 of the HCP)
13. Implementation of a City of San Marcos household hazardous waste program (Section 5.7.5 of the HCP)

14. Implementation of water quality protection and impervious cover limitation program (Section 5.7.6 of the HCP)

4. Texas State University – Covered activities for which incidental take is authorized:

f. Recreational activities within the University's jurisdiction in the San Marcos River and Spring Lake; including but not limited to, swimming, wading, tubing, boating, canoeing, kayaking, golf, diving, snorkeling and fishing, in accordance with all applicable laws and regulations (Section 2.5.1 of the HCP).

1. Establishment of permanent access points for recreation, and closure of unauthorized access points (Section 5.4.2 of the HCP).
2. Remove floating vegetation mats and litter from the River (Section 5.4.3.1 of the HCP).
3. Inorganic litter will be picked up weekly from the San Marcos River from Sewell Park to City Park during the recreational season (Memorial Day to Labor Day) and monthly during off-season (Section 5.4.3.2 of the HCP).
4. Operation and management of boating and kayak activities at Spring Lake (Section 5.4.10 of the HCP).

g. Educational activities including:

6. Diving for Science Program – trains volunteers to SCUBA in Spring Lake in a manner that protects listed species in order to assist with ecosystem maintenance activities including, but not limited to, algae and litter removal. Participants are required to be under the supervision of the Diving Supervisor, who will be an employee or representative of the Permittee (Texas State University) (Section 2.5.3.1 of the HCP).
7. Continuing Education SCUBA Classes – Use of the Spring Lake designated Dive Training Area (approximately 0.5 acres [2,140 square meters] in size) by Texas State University Continuing Education dive classes for no more than 10 check-out dives per semester. This use is limited to the Dive Training Area (Section 2.5.3.2 in the HCP).
8. Texas State University SCUBA Classes – Texas State University SCUBA classes limited to a maximum of 3 classes per day, with no more than 12 students per class. This use is limited to the Dive Training Area (Section 2.5.3.3 of the HCP).
9. Research activities in Spring Lake, in accordance with all applicable laws and regulations (Section 2.5.4 of the HCP).
10. Texas State University canoeing and kayaking classes in Spring Lake and Sewell Park (Section 2.5.7 of the HCP).

h. Management of the ecosystems of the San Marcos River and Springs, its boating activities in Spring Lake and Sewall Park.

i. The permitted diversion of water from Spring Lake and the San Marcos River in accordance with applicable laws and regulations (Section 2.5.5 of the HCP).

j. Ongoing operation and maintenance of the existing nine-hole University golf course and grounds (section 2.5.6 of the HCP).

j. Minimization and mitigation measures that the University will either implement or have responsibility for implementing as identified in Chapter 5 of the HCP include:

    1. Enhancement and restoration Texas Wild-rice (Section 5.3.1 of the HCP) (Section 5.4.1 of the HCP)
    2. Management of public recreation at San Marcos Springs and the San Marcos River (Section 5.4.2)
    3. Management of aquatic vegetation from Sewell Park to City Park (Section 5.4.3)
    4. Removal of harmful erosion-related sediment in Spring Lake and from Spring Lake Dam to City Park (Section 5.4.4)
    5. Management of surface water diversion (Section 5.4.5)
    6. Restoration of native riparian vegetation (Section 5.7.1)
    7. Removal of harmful erosion-related sand bar in Sessom Creek Sand (Section 5.4.6)
    8. Management of research programs in Spring Lake (Section 5.4.8)
    9. Reduction of non-native species introduction (Section 5.4.11 & 5.7.1)
    10. Management of non-native plant species (Section 5.4.12)
    11. Management of harmful non-native and predator species (Section 5.4.13)

5. San Antonio Water System (SAWS) – Covered activities for which incidental take is authorized:

    b. Pumping from the Edwards Aquifer and for use and operation of the SAWS ASR (Section 2.6 of the HCP).

    c. Minimization and mitigation measures and measures that SAWS will either implement or have responsibility for implementing as identified in Chapter 5 of the HCP include:

        1. Use of the SAWS ASR for Springflow Protection. (Section 5.5.1).
        2. Phase II Expanded Use of the SAWS ASR and Water Resources Integration Program Pipeline. (Section 5.5.2).

6. The Permittees are jointly responsible for the following measures that specifically contribute to recovery – Covered activities for which incidental take is authorized:

    a. Comal Springs, Landa Lake, and the Comal River:

        1. The Permittees will limit disturbance of the (a) substrate, (b) water quality, (c) plants, and (d) animals of the Comal Springs, Landa Lake, and Comal River to no more than 10% of the occupied habitat on an annual basis when implementing HCP measures such as habitat and riparian restoration efforts that may directly or indirectly affect species considered here; and,
        2. The Permittees will suspend activities such as habitat restoration and riparian

restoration that may result in disturbance of the (a) substrate, (b) water quality, (c) plants, and (d) animals or invertebrates of the Comal Springs, Landa Lake, and the Comal River when Comal Springflows decline to 130 cfs or lower.

b. San Marcos Springs, Spring Lake, and the San Marcos River:

1. The Permittees will limit disturbance of the (a) substrate, (b) water quality, (c) plants, and (d) animals of the San Marcos Springs, Spring Lake, and the San Marcos River to no more than 10% of the occupied habitat on an annual basis when implementing HCP measures such as habitat and riparian restoration efforts that may directly or indirectly affect species considered here; and,
2. The Permittees will suspend activities such as habitat restoration and riparian restoration that may result in disturbance of the (a) substrate, (b) water quality, (c) plants, and (d) animals or invertebrates of the San Marcos Springs, Spring Lake, and the San Marcos River when San Marcos Springflows decline to 120 cfs or lower.

J. Upon locating a dead, injured, or sick individual of the covered species, or any other endangered or threatened species, the Permittee is required to contact the Service's Law Enforcement Office in Austin, Texas, (512) 490-0948 for care and disposition instructions. Extreme care should be taken in handling sick or injured individuals to ensure effective and proper treatment. Care should also be taken in handling dead specimens to preserve biological materials in the best possible state for analysis of cause of death. In conjunction with the care of sick or injured endangered/threatened species, or preservation of biological materials from a dead specimen, the Permittee and any contractor/subcontractor has the responsibility to ensure that evidence intrinsic to the specimen is not unnecessarily disturbed.

K. Conditions of the permit shall be binding on, and for the benefit of, the Permittees and any successors and/or assignees. If the permit requires an amendment because of change of ownership, the Service will process in accordance with regulations (50 CFR 13.23). The new Permittee must meet issuance criteria per regulations at 50 CFR 13.25. The covered activities proposed or in progress under the original permit may not be interrupted provided the conditions of the permit are being followed.

L. If, during the tenure of the permit, the project design and/or the extent of the habitat impacts is altered, such that there may be an increase in the anticipated take of the covered species, the Permittee is required to contact the Service's Austin Ecological Services Office (ESFO) and obtain an amendment to this permit before commencing any construction or other activities that might result in take beyond that authorized by the permit. If authorized take is exceeded, all activities that are shown to cause take must immediately cease and any take above that authorized shall be reported to the Austin Ecological Services Field Office (505/490-0057) within 48 hours.

M. If actions associated with implementation of the EARIP Habitat Conservation Plan are shown to result in incidental take of listed species not covered by the permit, those activities that are shown to cause take must immediately cease and any take that has occurred shall be reported to the Austin Ecological Services Field Office (505/490-0057) within 48 hours.

N. The Applicants shall monitor the project and ensure appropriate and relevant information (as specified below) on the project is provided in a timely manner to the Service.

O. CHANGED CIRCUMSTANCES

The EARIP provides measures for the following changed circumstances (Section 8.8.1 of the HCP):

1. New species listings or critical habitat designations
2. Covered Species adversely affected by an acute pollution event
3. Covered Species adversely affected by invasive species
4. Covered Species adversely affected by flooding
5. Inability to use the Phase I SAWS ASR as set out in Section 5.5 to achieve springflow protection
6. Recreational activities having adverse effects
7. Financial Assurance for any Phase II Measure
8. The Phase II presumptive measure is unable to function as expected within the stated assumptions.
9. EAA-Specific Changed Circumstances regarding water withdrawal (i.e. pumping) permits:
   a. EAA authorization of withdrawals from the Edwards Aquifer for the owners or lessees making such withdrawals pursuant to a Term Permit (Section 8.1 of the HCP).
   b. EAA authorization of any withdrawals under an emergency permit and for the owners or lessees making the authorized withdrawals under any emergency permit (Section 8.1 of the HCP).
   c. EAA authorization of any withdrawals under Recharge Recovery Permits and for the owners or lessees of the water making the authorized withdrawals under any Recharge Recovery Permit (Section 8.1 of the HCP).

Changed Circumstances not provided for in the HCP (Section 8.1.2):

10. Invasion by exotic species and/or habitat-specific or species-specific disease that threaten Covered Species or their habitats and which cannot be effectively controlled by currently available methods or technologies or which cannot be effectively controlled without resulting in greater harm to other Covered Species than to the affected Covered Species.

P. MONITORING REQUIREMENTS

1. The Permittees will monitor compliance with the HCP and provide an annual report as described below.

2. The Permittees will develop a monitoring program to determine if progress is being made toward meeting the long-term biological goals and objectives.
3. The Permittees will develop and oversee a monitoring program to identify and assess potential impacts, including incidental take, from Covered Activities and provide a better understanding and knowledge of desirable water quality- and springflow-related habitat requirements of the Covered Species, including the species' life cycles (section 6.3 of the HCP).

P. Annual Reporting:

1. The EARIP Applicants will provide an annual report, due on March 31 of each year, to:

   U.S. Fish and Wildlife Service
   Austin Ecological Services Field Office
   10711 Burnet Road, Suite 200
   Austin, Texas 78758

   U.S. Fish and Wildlife Service, Region 2
   Habitat Conservation Plans and Research Permits
   P.O. Box 1306, Room 4102
   Albuquerque, New Mexico 87103

2. The report will document the activities and EARIP Permittees permit compliance for the previous year, thus documenting progress toward the goals and objectives of the HCP and demonstrating compliance with the terms and conditions of the incidental take permit. The annual report will include:

   a. EAA Permitted withdrawals
   b. Reference well levels
   c. Springflows at Comal and San Marcos Springs
   d. Aquifer recharge
   e. Aquifer discharge from wells and springflow
   f. Critical period management reductions
   g. Water quality data
   h. Location of sampling sites
   i. Methods for data collection and variables measured
   j. Frequency, timing, and duration of sampling for the variables
   k. Description of the data analysis and who conducted the analysis

3. The report will document HCP Management activities, including:

   a. Adaptive management activities undertaken during the year
   b. Expenditures by the EAA on implementation activities
   c. Proposed activities for the next year
   d. Report on the status of implementation of minimization and mitigation measures and their effectiveness

e. Interim updates and final copies of any research, thesis or dissertation, or published studies accomplished in association with the EARIP or HCP
f. Description of species-specific research and management actions undertaken with specific reference to the biological goals and objectives identified for each species.
g. Any changes to the Biological Goals and Key Management and Flow-related Objectives of the HCP
h. Any changes to the objectives for the monitoring program
i. Effects on the Covered Species or Permit Area
j. Evaluation of progress toward achieving the Biological Goals and Objectives.
k. Any recommendations regarding actions to be taken.

4. Information provided in the annual report will be used to determine what, if any, adaptive management strategies should be implemented to most effectively implement the conservation program outlined in the HCP and to ensure that management changes in response to new, appropriate data are implemented in a timely fashion.

Conservation Recommendations

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a action on listed species or critical habitat, to help implement recovery plans, or to develop information. We provide the following conservation recommendations:

1. Plan and implement or assist efforts to assess the rangewide status of the Comal Springs dryopid beetle to improve our understanding of abundance, distribution, and life history requirements.
2. Plan and implement or assist efforts to assess the rangewide status of the Comal Springs riffle beetle to improve our understanding of abundance, distribution, and life history requirements.
3. Plan and implement or assist efforts to assess the rangewide status of the Peck's cave amphipod to improve our understanding of abundance, distribution, and life history requirements.
4. Plan and implement or assist efforts to assess the rangewide status of the golden orb, Texas pimpleback and Texas fatmucket mussels Rivers to improve our understanding of abundance, distribution, and life history requirements for these species.
5. Plan and implement or assist efforts to assess the rangewide status of the fountain darter to improve our understanding of abundance, distribution, and life history requirements.
6. Plan and implement or assist efforts to assess the rangewide status of the San Marcos gambusia in the San Marcos River to improve our understanding of abundance, distribution, and life history requirements.
7. Plan and implement or assist efforts to assess the rangewide status of the San Marcos salamander to improve our understanding of abundance, distribution, and life history requirements.

8. Plan and implement or assist efforts to assess the rangewide status of the Texas blind salamander to improve our understanding of abundance, distribution, and life history requirements.
9. Assist with restoration and protection of native riparian vegetation near the spring runs at Landa Lake, and adjacent to Spring Lake and the Comal and San Marcos Rivers.
10. Assist with restoration of a mixture of native aquatic vegetation in Landa Lake, Spring Lake and the Comal and San Marcos Rivers.
11. Assist with efforts to further reduce the likelihood of traffic accidents and contaminant spills near Landa Lake, the Comal River, and its tributaries.
12. Assist with efforts to improve the water quality of runoff from New Braunfels and San Marcos to the Comal and San Marcos River systems including but not limited to stormwater associated with roads.
13. Assist with additional efforts to avoid and minimize human disturbance of the Comal and San Marcos Rivers.
14. Assist with propagation and reintroduction techniques for these species being developed by the Service's San Marcos Aquatic Resources Center, the Uvalde National Fish Hatchery, and the Inks Lake National Fish Hatchery.
15. Assist with the implementation of recovery tasks identified for these species in their respective Recovery Plans.

We request notification of the implementation of any conservation recommendations so we may be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats.

9. Review Requirements

The reasonable and prudent measures, with their implementing terms and conditions, are designed to avoid, minimize, and mitigate effects of incidental take that might otherwise result from the issuance of the permit and implementation of the associated HCP. If, during the course of the authorized activities, this level of incidental take is exceeded prior to the annual review, such incidental take represents new information requiring review of the reasonable and prudent measure provided. The Austin Ecological Services Field Office must immediately provide an explanation of the causes of the taking and review the need for possible modification of the reasonable and prudent measures with the Chief of Endangered Species, Southwest Regional Office. This biological opinion will expire at the expiration of the incidental take permit issued to implement the EARIP HCP.

10. Reinitiation Notice

This concludes formal consultation on the issuance of a Service 10(a)(1)(B) permit for the EARIP Habitat Conservation Plan that minimizes and mitigates, to the maximum extent practicable, adverse effects to the endangered Texas wild-rice, Comal Springs dryopid beetle, Comal Springs riffle beetle, Peck's Cave amphipod, fountain darter, San Marcos gambusia, Texas blind salamander, the threatened San Marcos salamander, and the non-listed Edwards Aquifer diving beetle, Texas troglobitic water slater, and Comal Springs salamander from covered activities described in the HCP over a period of 15-years. As provided in 50 CFR § 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this consultation; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any activities causing such take must cease pending reinitiation.

If you have any questions regarding this biological opinion, please contact Tanya Sommer at 512/490-0057, extension 222.

Approved:

Adam Zerrenner, Field Supervisor
Austin Ecological Services Field Office

1/3/2013
Date

Concur:

Acting **Assistant Regional Director**
Ecological Services, Region 2

1/28/13
Date

Non-concur:

Assistant Regional Director
Ecological Services, Region 2

Date

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